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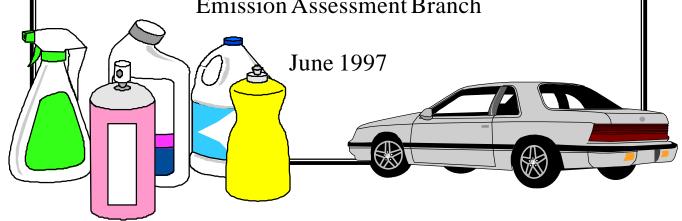


Air Resources Board

## Perchloroethylene Needs Assessment for Automotive Consumer Products

## Status Report

Stationary Source Division Emission Assessment Branch



### State of California California Environmental Protection Agency

Air Resources Board Stationary Source Division P.O. Box 2815 Sacramento, California 95812

## STATUS REPORT PERCHLOROETHYLENE NEEDS ASSESSMENT FOR AUTOMOTIVE CONSUMER PRODUCTS

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This status report has been reviewed by the staff of the Air Resources Board and approved for release. Approval does not signify that the contents necessarily reflect the views and policies of the Air Resources Board; nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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#### TABLE OF CONTENTS

Conte	<u>ents</u>	<u>Page</u>
I.	INT	RODUCTION
	1. 2.	Why are we reviewing Perc use in automotive consumer products? 1 What authority does the ARB have to reduce Perc in the air and what actions have been taken?
II.	PUB	LIC OUTREACH AND REPORT PREPARATION
	1. 2. 3. 4.	What outreach efforts have the staff made to involve interested parties? 3  How have the brake service facility operators and consumer product manufacturers participated in the development of the status report? 4  Who else has been involved in the process? 4  What methods were used to collect information for the status report?
III.	FINI	DINGS
	1. 2. 3.	What do we know about Perc usage in brake cleaning products in California? . 5 How are brake jobs performed?
IV.	POT	TENTIAL HEALTH EFFECTS AND HEALTH RISKS
	1. 2.	What are the potential health effects associated with exposure to Perc? 8 What tools and information are used to estimate a facility's potential health impacts? 9
	<ul><li>3.</li><li>4.</li></ul>	What are the potential health impacts to individuals from exposure to a brake service facility using Perc-containing cleaners?
v.		COMMENDATIONS
REF	EREN	CES

<u>Contents</u>	Pag	<u>e</u>
APPENDICE	ES	
Appendix A	- Brake Cleaner and Perc-Containing Automotive Products Survey A-1	
Appendix B	- Brake/Automotive Repair Shop Survey B-1	
Appendix C -	- Summary of the Different Types of Brake Service Facilities	
Appendix D	- Health Effects and Example Risk Assessment Calculations D-1	
Appendix E -	- Glossary E-1	
LIST OF TA	BLES	
Table III-1.	Summary of Survey Information	<u>,</u>
Table III-2.	Emission Estimates from Site Visits	,
Table IV-1.	Summary of Near-Source Potential Health Impacts	ļ
Table IV-2.	Summary of Potential Health Impacts at the Maximum Exposed Individual Resident (MEIR)	;
Table IV-3.	Summary of Potential Health Impacts at the Maximum Exposed Individual (Off-site) Worker (MEIW)	į

## STATUS REPORT PERCHLOROETHYLENE NEEDS ASSESSMENT FOR AUTOMOTIVE CONSUMER PRODUCTS

In this status report, the Air Resources Board (ARB/Board) staff presents its findings on perchloroethylene (Perc) use in automotive consumer products, particularly brake cleaning products. We conclude with our recommendations to the Board on future activities related to the control of Perc in automotive consumer products.

#### I. INTRODUCTION

#### 1. Why are we reviewing Perc use in automotive consumer products?

At the November 21, 1996, hearing, the Board adopted amendments to exempt Perc from the volatile organic compound (VOC) definition in California's Regulation for Reducing VOC Emissions from Consumer Products (Consumer Products Regulation). This action would allow manufacturers to reformulate consumer products with Perc to meet the VOC limits of the Consumer Products Regulation.

During the hearing, the Board expressed concerns about the potential increase in Perc use in consumer products, and the possible health impacts that might result. Therefore, the Board directed the ARB staff to conduct an assessment under the State toxic air contaminant program of the need for control of Perc used in consumer products, and to report on the status of this assessment to the Board no later than June 1997. At the hearing, automotive consumer products, and specifically brake cleaners, were identified as the consumer products most likely to contain, or be reformulated to contain, Perc. Consequently, this status report presents the Perc Needs Assessment for Automotive Consumer Products (Perc Needs Assessment) with an emphasis on brake cleaners.

This status report summarizes the findings of the ARB staff, including the survey of automotive consumer products manufacturers, site visits to automotive brake service facilities, Perc emissions and potential risk, and recommendations for future action.

## 2. What authority does the ARB have to reduce Perc in the air and what actions have been taken?

The authority to control air toxics was established by Assembly Bill 1807 (1983). This law mandates the identification and control of air toxics in California and complements the criteria air pollutant program. The identification phase of the program allows the ARB, with the participation of other state agencies, to evaluate the health impacts and exposure of substances

and identify those which pose the greatest health threat as toxic air contaminants. The Board identified Perc as a toxic air contaminant (TAC) at its October 1991 hearing.

Following the identification of a substance as a TAC, Health and Safety Code section 39665 requires the ARB, with participation of the air pollution control and air quality management districts (districts), and in consultation with affected sources and interested parties, to prepare a report on the need and appropriate degree of regulation for that substance. The needs assessment for Perc was conducted as part of the ARB's development of an airborne toxic control measure (ATCM) for dry cleaning operations. During this assessment, the ARB staff determined that dry cleaning operations and solvent degreasing operations accounted for about 80 percent of the Perc use in California. Therefore, staff focussed their attention on these two uses of Perc first.

In September 1993, the Board adopted the ATCM for Emissions of Perchloroethylene from Dry Cleaning Operations (Dry Cleaning ATCM) (Title 17, California Code of Regulations, Sections 93109 and 93110). When fully implemented in 1998, this ATCM will result in a 78 percent reduction in statewide Perc emissions from Perc dry cleaning operations.

In 1990, the United States Environmental Protection Agency (U.S. EPA) identified Perc as a hazardous air pollutant (HAP). In December 1994, U.S. EPA promulgated the National Emission Standard for Hazardous Air Pollutants: Halogenated Solvent Cleaning (the Degreasing NESHAP) to address halogenated solvents emissions, including Perc, from degreasing operations. In California, the Degreasing NESHAP is the State ATCM for degreasing operations; therefore, it must be implemented and enforced by the districts, unless the districts seek and receive approval from U.S. EPA to implement an alternative control measure. Sources subject to the Degreasing NESHAP have to comply with this regulation beginning on December 2, 1997.

In addition, the ARB staff is finalizing the Risk Reduction Audits and Plans Guidelines for Halogenated Solvents Degreasing Operations to assist facilities who have been identified by the districts as significant risk facilities under the Assembly Bill (AB) 2588 "Hot Spots" Program and Senate Bill 1731 (Health and Safety Code sections 44390 to 44394). This guideline document contains a self-conducted audit and checklist which will help a facility operator determine possible options to reduce a facility's risk from degreasing operations.

In reviewing the criteria for facilities subject to the AB 2588 "Hot Spots" program, brake service facilities are not required to complete emissions inventory plans and submit these plans to the districts. Although retail gasoline service stations are currently subject to the "Hot Spots" program, the districts typically require the reporting of only the toxic emissions from gasoline dispensing, even if other operations such as brake cleaning operations are occurring. In general, the districts can bring any individual facility into the "Hot Spots" program if they determine that the facility poses a significant risk to the public.

The ARB has the authority to control consumer products as established in Health and Safety Code section 41712. Pursuant to this authority, the Board adopted the aerosol coatings regulation which essentially prohibits "new or increased uses" of Perc. The aerosol coatings regulation allows Perc-containing aerosol coatings to be sold or used in California if they were sold in the State in 1992 and complied with the standards of the aerosol coatings regulation. It also allows Perc-containing aerosol coatings to be sold or used in California if they were sold in the State in 1992 and could be reformulated to comply with the standards of the aerosol coatings regulation without increasing the Perc content. Perc-containing aerosol coatings that were not sold or used in California in 1992, or those that were which could not be reformulated to comply with the standards of the aerosol coatings regulation without increasing the Perc content, are not allowed.

#### II. PUBLIC OUTREACH AND REPORT PREPARATION

Outreach and public participation have always been important components in our report preparation process. For the Perc Needs Assessment, we developed an outreach program to involve consumer products manufacturers and their associations, brake service facilities, state and local regulatory agencies, and other interested parties in the assessment process, including the development and review of the necessary surveys and draft reports. Our goal is to work with industry and the interested parties to obtain information on the use and emissions of Perc-containing automotive consumer products and to provide all parties a forum to address their concerns.

#### 1. What outreach efforts have the staff made to involve interested parties?

We have made extensive personal contacts with industry and facility representatives as well as other affected parties through meetings and telephone calls. To date, we have:

- formed a Perc Needs Assessment workgroup and conducted three conference calls with them to discuss our activities;
- mailed or faxed workgroup agendas and minutes, and workshop notices to over 80 people;
- mailed or faxed the Brake Cleaner and Perc-Containing Automotive Products Survey to 60 people comprised of manufacturers, associations, and interested parties (see section II.4 for additional details);
- released a draft status report of the Perc Needs Assessment for review and comment prior to the workshop;
- held a public workshop; and
- visited 37 brake service facilities to gather information on the process and amount of brake cleaning products used, building dimensions, and receptor locations (see section II.4). Staff will be conducting more site visits prior to the June Board meeting.

## 2. How have the brake service facility operators and consumer products manufacturers participated in the development of the status report?

The automotive consumer products manufacturers and brake service industry representatives have been participants in the assessment process. Individual manufacturers and brake service facility operators have provided both technical information and comments on our survey and preliminary findings. Industry involvement in the process has included:

- more than 250 telephone conversations with the ARB staff;
- input on the development of the manufacturer's survey;
- 22 surveys returned by manufacturers; and
- participation of 18 workgroup representatives to review the survey and risk assessment results.

#### 3. Who else has been involved in the process?

To promote statewide consistency and provide a multi-media perspective, other local, state, and federal agencies that are interested in potential emissions or soil/groundwater contamination by Perc have been involved in the assessment process. These agencies include: the air districts, sanitation districts, the California Department of Industrial Relations/Division of Occupational Safety and Health (Cal/OSHA), Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA), and the U.S. EPA.

We have worked with the districts through the California Air Pollution Control Officers Association's (CAPCOA) Toxics Committee to apprise them of our activities. We have also requested information that they may have on the brake cleaning process and how districts regulate the brake service industry. This work has included telephone calls to the districts and presentations to the CAPCOA Toxics Committee.

Additionally, we have had several conversations with a representative of the Institute for Research and Technical Assistance (IRTA), a non-profit organization that assists small businesses with chemical and process substitutions to decrease the use of halogenated solvents. We also had conversations with representatives of TriTac, a technical advisory committee sponsored by the League of California Cities, the California Association of Sanitation Agencies, and the California Water Environment Association.

#### 4. What methods were used to collect information for the status report?

ARB staff developed two surveys to gather Perc usage and emissions data for use in this status report: the Brake Cleaner and Perc-Containing Automotive Products Survey (Brake Cleaner Survey), and the Brake/Automotive Repair Facility Survey for site visits (Site Visit Survey). The Brake Cleaner Survey (see Appendix A) was developed to gather current sales and formulation data for both chlorinated and non-chlorinated brake cleaning products. It also

requested information on future formulation trends that could increase the Perc content of brake cleaning products and other automotive consumer products. The Site Visit Survey (see Appendix B) was developed to gather brake service facility process information and source characteristic information. Process information includes items such as the number of brake jobs performed per day and the amount and types of solvent used in the process. Process information was used to estimate facility emissions. Source characteristic information includes building dimensions and the location of the nearest receptor, and is used, in conjunction with facility emissions and an air dispersion model, to assess risk from a given facility.

#### III. FINDINGS

#### 1. What do we know about Perc usage in brake cleaning products in California?

The U.S. EPA was required under section 183(e) of the 1990 Clean Air Act Amendments to conduct a study of VOC emissions from consumer products; therefore, the U.S. EPA surveyed consumer products manufacturers, retailers, distributors, and packagers for information on 1990 U.S. sales data, product formulations, product size, product form, and other information for each product surveyed. Automotive consumer products, including brake cleaning products, were contained in this survey. This information is reflected in the 1990 U.S. EPA Consumer and Commercial Products Database (U.S. EPA 1990 Database).

The U.S. EPA 1990 Database indicated that brake cleaning products use the largest total percentage of Perc of the products surveyed. It was estimated from the U.S. EPA survey that the use of brake cleaners in California accounted for about 470,000 pounds per year (lbs/yr) of Perc, or about 45 percent of consumer products Perc usage. Other users of Perc in consumer products include dry cleaning fluids, spot removers, and carburetor choke cleaners. Due to its substantial use, we are focusing on brake cleaning products in this status report.

As of May 23, 1997, 22 of the 37 surveys sent to manufacturers in March 1997 have been returned. From the returned surveys, we received information on 89 different brake cleaning products, 33 of which contain Perc. Based on reported sales of over 2,000,000 units ranging in size from 10 ounces to 55 gallons and Perc content from about 22 to 98 percent, staff calculated a Perc usage of approximately 3,900,000 pounds per year (lbs/yr) or 290,000 gallons per year (gal/yr) from Perc-containing brake cleaning products. We estimate that Perc usage for the remaining 15 manufacturers accounts for less than ten percent of the total, based on a 1990 ARB survey.

The amount of Perc from the Brake Cleaner Survey is more than the estimated Perc use from brake cleaning products in the U.S. EPA 1990 Database (3,900,000 lbs/yr versus 470,000 lbs/yr.). It is important to note that the estimate from the U.S. EPA 1990 Database may not be representative of California usage since it was based on a nationwide survey. However, some of the increase may be attributed to the reformulation of brake cleaning products that

contained 1,1,1-trichloroethane (TCA) with Perc. For comparison, 1991 Perc usage in dry cleaning operations was approximately 14,800,000 lbs/yr or 1,100,000 gal/yr (ARB, 1993). Table III-1 summarizes the data from the surveys returned as of May 23, 1997.

Table III-1. Summary of Survey Information<sup>1</sup>

Product Type	Number of Products	Product Size <sup>2</sup>		Units Sold in	Number of Products	
		Aerosol (oz)	Liquid (gal)	Industrial/ Institutional	Retail/ Household	That Will Reformulate <sup>3</sup>
Perc Products	33	10 to 22	1 to 55	1,883,604	254,009	0
Non-Perc Products	56	12 to 21	1 to 55	2,397,228	377,901	2

<sup>1.</sup> Based on the 22 surveys that have been returned.

#### 2. <u>How are brake jobs performed?</u>

Brake service operations are normally performed directly on the vehicle, with the vehicle raised to a comfortable working height for the mechanic. Brake service operations can include inspections, adjustments, brake pad replacements, and rotor resurfacing, and usually require the disassembly, repair, and reassembly of the brakes.

Automotive brake cleaners are routinely used in brake services. Automotive brake cleaners are products designed to remove oil, grease, brake fluid, brake pad dust, or dirt from motor vehicle brake mechanisms and generally come in either an aerosol or liquid form. Brake cleaners are applied before, during, and after brake disassembly to dissolve contaminants, and sometimes after reassembly as a final cleaning process to remove oil, brake fluid, and fingerprints. After application, the brake cleaner and dissolved contaminants either drip off, or are wiped away from the brake parts.

To control asbestos exposure from brake and clutch surfaces, the Cal/OSHA adopted mandatory methods for brake and clutch service beginning on July 3, 1996 (Title 8, California Code of Regulations, Section 5208, Appendix F). This regulation requires that either a negative pressure enclosure/HEPA vacuum system, or a low pressure/wet method using an aqueous solution, be used to clean asbestos containing brake parts during brake and clutch inspection, disassembly, repair, and assembly operations. However, mechanics can use any brake cleaning product they choose after the reassembly process to remove fingerprints, residual grease, and brake fluid. In addition, mechanics may use any brake cleaning products, including water, petroleum solvent parts washers, or other brake cleaners for cleaning non-asbestos containing brakes. For these purposes, some mechanics use aerosol brake cleaners.

<sup>2.</sup> All numbers have been rounded.

<sup>3.</sup> Includes only products whose reformulation would increase their Perc content.

Aerosol brake cleaners are available in either chlorinated or non-chlorinated formulations. Chlorinated aerosol brake cleaners can contain Perc, in addition to methylene chloride and petroleum distillates in varying concentrations. Non-chlorinated aerosol brake cleaners may contain petroleum distillates, toluene, xylenes, methanol, acetone, or other organic solvents. Both types of aerosol brake cleaners dry quickly and clean without leaving a residue. However, both types also have disadvantages in that the chlorinated aerosol may have warning labels due to the potential toxicity of the compounds used, and the non-chlorinated aerosols may be flammable. It is the mechanic's preference on which type of aerosol product is used.

#### 3. How much Perc is emitted from the use of brake cleaning products?

In quantifying Perc emissions from brake cleaning products, ARB staff looked at various studies, including those by the ARB, U.S. EPA, and John Norton of George Mason University (Norton, 1993), and could not find information representative of California brake service facilities. To estimate Perc emissions from individual brake service facilities, staff collected information from 37 site visits to brake service facilities in several areas throughout the State. As mentioned previously, the type of information gathered included: the number of brake jobs performed per day, the amount and types of solvent used in the process, and source characteristic information such as building dimensions and the location of the nearest receptor. Of the 37 site visits, only 16 facilities used Perc-containing products in their brake servicing process.

The staff also collected information from the California Board of Equalization, the California Department of Consumer Affairs' Bureau of Automotive Repair, and the United States Economic Census to estimate that there are about 31,000 to 34,000 automotive service and repair facilities in California (BOE, 1997a; BOE, 1997b; BAR, 1997; U.S. Economic Census, 1992). Using the standard industrial classification (SIC) breakdown within the United States Economic Census, we estimated that approximately 21,000 of these facilities may perform brake services in California. These facilities can be grouped into five categories: service stations, fleets, new and used car dealerships, brake shops, and general automotive repair facilities. A description of each facility category is given in Appendix C.

The site visit information indicated that the quantity of Perc that is emitted per each brake job varies with several factors. These factors include the mechanic who is servicing the vehicle, the Perc content in a particular brand of brake cleaner, and the manner in which the product is used. Emissions are also impacted by the size and operating schedule of the facility. This variability has made it difficult to accurately express emissions as a function of product usage per brake job in a generic fashion.

The shops that were visited did not have pre-established guidelines outlining how much product was to be used, but relied upon what the mechanic felt was an appropriate amount to complete the task. Furthermore, the aerosol spray cans that contain the products come in several sizes with the Perc content ranging from 1 percent to 100 percent according to manufacturers' material safety data sheets. This makes it difficult to extract a representative average for Perc

concentration in the products. Some facilities also reported using brake cleaning products for small parts cleaning and degreasing on a limited basis. As a result, the emission estimates summarized in Table III-2 for three service stations, three fleet operations, two car dealerships, two brake shops, and six general automotive repair facilities reflect the variability in the use of brake cleaning products and limited small parts cleaning activities. These emission estimates are used in the risk assessment modeling. Based on observations during site visits, ARB staff concluded that 100 percent of the Perc contained in aerosol brake cleaners is emitted to the air when used.

**Table III-2. Emission Estimates from Site Visits** 

Facility Category	Number of Facilities Visited	Range of Annual Perc Emissions [gallons/year] 1	Range of Annual Perc Emissions [pounds/year] 1,2
Service Stations	3	1.5 to 6.7	20 to 90
Fleets	3	1.4 to 97	19 to 1307
New and Used Car Dealerships	2	3 to 24	41 to 325
Brake Shops	2	4.3 to 11	58 to 152
General Automotive Repair	6	0.3 to 51	4.3 to 697

<sup>1.</sup> All numbers have been rounded.

#### IV. POTENTIAL HEALTH EFFECTS AND HEALTH RISKS

#### 1. What are the potential health effects associated with exposure to Perc?

Exposure to Perc may result in both cancer and non-cancer health effects. The OEHHA staff has performed an extensive assessment of the potential health effects of Perc, reviewing available carcinogenicity data. OEHHA concluded that Perc is a possible human carcinogen with no identifiable threshold below which no carcinogenic effects are likely to occur. As mentioned previously, the Board formally identified Perc as a toxic air contaminant (TAC) in October 1991. The U.S. EPA has also listed Perc as a hazardous air pollutant (HAP) pursuant to section 7412 of Title 42 of the United States Code (ARB, 1996).

Short-term (acute) and long-term (chronic) exposure to Perc may result in non-cancer health effects. Acute toxic health effects resulting from short term exposure to high levels of Perc may include headaches, dizziness, rapid heartbeat, and irritation or burns on the skin, eyes, or respiratory tract. Massive acute doses can induce central nervous system depression resulting in

<sup>2.</sup> Perc density: 13.47 pounds per gallon at 25 degrees Celsius.

respiratory failure. Chronic exposure to lower Perc concentration levels may result in dizziness, impaired judgement and perception, and damage to the liver and kidneys (ARB, 1996).

## 2. What tools and information are used to estimate a facility's potential health impacts?

The tools and information that are used to estimate the potential health impacts from a facility include an air dispersion model and pollutant-specific health effects values. Information required for the air dispersion model includes emission estimates and physical descriptions of the source and emission release parameters. Combining the output from the air dispersion model and the pollutant-specific health values provides an estimate of the off-site potential cancer and non-cancer health impacts from the emissions of a toxic air contaminant. For this assessment, we are estimating the potential health impacts from Perc emitted during brake service operations. A brief description of the air dispersion modeling and pollutant-specific health effects values is provided in this section. A more detailed discussion, including an example calculation, is presented in Appendix D.

#### a. <u>Air Dispersion Modeling</u>

Air dispersion models are used to estimate the downwind, ground-level concentrations of a pollutant emitted from a facility. The downwind concentration is estimated by evaluating the quantity of emissions, release parameters at the source, and appropriate meteorological conditions. The SCREEN3 air dispersion model, version 96043, is used to estimate potential ground-level concentrations due to Perc emissions from brake service facilities. The U.S. EPA recommends the SCREEN3 model for air dispersion modeling and it is currently used by the ARB, districts, and other states (U.S. EPA, 1995).

#### b. <u>Pollutant-Specific Health Effects Values</u>

Dose-response or pollutant-specific health effects values are developed to characterize the relationship between a person's exposure to a pollutant and the incidence or occurrence of an adverse health effect. A unit risk factor (URF) or cancer potency factor is used when estimating potential cancer risks and reference exposure levels (REL) are used to assess potential non-cancer health impacts.

As stated above, exposure to Perc may result in both cancer and non-cancer health effects. The inhalation URF is 5.9 x  $10^{-6}$  (microgram per cubic meter)<sup>-1</sup> or ( $\mu$ g/m³)<sup>-1</sup> (CAPCOA, 1993). The URF is defined as the estimated upper-confidence limit (usually 95%) probability of a person contracting cancer as a result of constant exposure to a concentration of  $1 \mu$ g/m³ over a 70-year lifetime. In other words, the potential excess cancer risk for a person continuously exposed over a 70-year lifetime to  $1 \mu$ g/m³ of Perc is estimated to be no greater than 5.9 chances in 1 million.

Non-cancer acute and chronic RELs have been developed for Perc. The acute non-cancer REL is  $6.8 \times 10^3 \,\mu\text{g/m}^3$  (CAPCOA, 1993). The toxicological endpoint considered for acute toxicity is

the central nervous system. The chronic REL is 35  $\mu$ g/m³ (CAPCOA, 1993). The toxicological endpoints considered for chronic toxicity are the kidney, liver, and gastrointestinal system.

## 3. What are the potential health impacts to individuals from exposure to a brake service facility using Perc-containing brake cleaners?

The ARB staff conducted a screening risk assessment for 16 of the facilities that staff visited and found to be using Perc-containing brake cleaners. These 16 facilities are a subset of the 37 brake service facilities where ARB staff has conducted site visits. The other 21 facilities were not assessed because they did not use Perc-containing products.

Table IV-1 summarizes the maximum potential cancer and non-cancer health impacts. The maximum potential health impacts are estimated to occur at near-source locations. For these 16 facilities, we selected a minimum receptor distance of 20 to 30 meters from the center of the volume source or building to define a near-source location. The purpose of estimating the potential health impacts at a near-source location is to illustrate what the potential health impacts can be if a receptor was located close to the facilities which were assessed, rather than having an increased "buffer" distance between the receptor and the edge of the building.

Tables IV-2 and IV-3 summarize the potential cancer and non-cancer health impacts at the maximum exposed individual resident (MEIR) and at the maximum exposed individual (off-site) worker (MEIW), respectively. Definitions of MEIR and MEIW can be found in the glossary (Appendix E). An example calculation is presented in Appendix D illustrating how a facility's potential risk was assessed. This example shows emission calculations, steps through the air dispersion modeling, and concludes with a calculation of potential health impacts.

#### a. <u>Summary of Carcinogenic Impacts</u>

From a carcinogenic standpoint, the near-source risk assessment results for the 16 facilities range from approximately 0.3 to 51 chances in a million. The individual results are presented in Table IV-1. Eight of the facilities are estimated to have near-source potential cancer risks that are greater than 10 chances per million. At fleet facility I, the potential near-source cancer risk ranges from approximately 33 to 47 chances per million at 20 meters from the center of the volume source (building). At dealership M, the potential near-source cancer risk is approximately 19 chances per million. At the general automotive repair facilities O, Q, R, T, and U, the potential near-source cancer risk ranges from approximately 11 to 51 chances per million. At brake shop P, the near-source potential cancer risk ranges from approximately 8.8 to 13 chances per million. The near-source potential cancer risks for the remaining 8 facilities are all below 10 chances per million.

For comparison purposes, the 1996 ambient statewide Perc concentration of  $0.92~\mu g/m^3$  (0.135 parts per billion or ppb) is determined from the ARB ambient air monitoring network. The ambient air monitoring network is designed to obtain ambient background, non-source-influenced,

concentration levels of air toxics, such as Perc, from 21 ambient air toxics monitoring stations located statewide. Using the ambient statewide Perc concentration, and assuming that a person is continuously exposed to this concentration for a 70-year lifetime, the potential risk from the measured 1996 Perc concentrations may increase the risk of cancer by approximately 5 chances per million. While this is only a rough estimate, this comparison puts into perspective the contribution to risk from the Perc-using facilities staff visited and the potential risk from the ambient concentration.

From 1991 to 1996, the ambient statewide Perc concentration has decreased by approximately 50 percent, from 0.271 to 0.135 ppb. The ARB staff estimated the 1991 annual Perc usage to be approximately 25 million pounds from all source categories surveyed during the development of the Dry Cleaning ATCM. Of this 25 million pounds, approximately 2.5 million pounds were estimated to result from the miscellaneous category. This miscellaneous category includes brake cleaning products as well as other aerosols, textiles, pharmaceuticals, and inks (ARB, 1993). There is insufficient data to quantify how the ambient reductions in Perc correspond to reductions in commercial and industrial Perc use. However, since 1991, contributions to the reduction of ambient levels and Perc use could be attributed to regulations or programs such as the Dry Cleaning ATCM and voluntary modifications to work practices from sources using Perc due to the AB 2588 Air Toxics "Hot Spots" Program (see section I.2).

Currently, we do not have an updated breakdown of Perc usage by source category. However, Brake Cleaner Survey results indicate that approximately 4 million pounds of Perc are used in brake cleaners alone. These preliminary results show that the 1996 Perc contribution from brake cleaners is larger than 1991 levels for this miscellaneous source category. Therefore, these results indicate that brake service facilities may constitute a larger fraction of the ambient risk. Further study would be required to fully quantify these results.

Table IV-1. Summary of Near-Source Potential Health Impacts<sup>1,2</sup>

Facility Type (n=16)	Individual Cancer Risk (per million)	Acute Hazard Index	Chronic Hazard Index
Service Stn. D	7.5	<0.1	<0.1
Service Stn. E <sup>3</sup>	2.0 to 2.9	<0.2	< 0.1
Service Stn. L <sup>3</sup>	4.7 to 6.8	<0.4	< 0.1
Fleet G	9.1	<0.1	< 0.1
Fleet H <sup>3</sup>	0.3 to 0.4	<0.1	< 0.1
Fleet I <sup>3</sup>	33 to 47	<0.3	<0.3
Dealership M	19	<0.1	< 0.1
Dealership N <sup>4</sup>	3.7	<0.1	< 0.1
Gen. Auto O <sup>3</sup>	11 to 16	<0.5	< 0.1
Gen. Auto Q <sup>3</sup>	27 to 39	< 0.6	< 0.2
Gen. Auto R <sup>3</sup>	35 to 50	<0.2	< 0.3
Gen. Auto T	51	<0.2	< 0.3
Gen. Auto U <sup>3</sup>	22 to 32	<0.2	<0.2
Gen. Auto V	0.5	<0.1	<0.1
Brake Shop P <sup>3</sup>	8.8 to 12.7	<0.1	<0.1
Brake Shop S	5.0	<0.1	<0.1

Near-source is defined as the modeled minimum receptor distance of 20 to 30 meters from the building center, or ranging from 2 to 16 meters away from the outside edge of the building.

The risk assessment results for the MEIR are presented in Table IV-2. At four of these facilities, the potential cancer risk at the MEIR is greater than 10 chances per million. At dealership M, where the MEIR is located approximately 15 meters away from the outside edge of the building, the potential cancer risk is approximately 17 chances per million. At the general auto facilities Q, R, and T, the potential MEIR risk ranges from approximately 8 to 30 chances per million for receptors ranging from 30 to 75 meters away from the outside edge of the building. At the other 12 facilities, the potential risk range from 0.01 to 10 chances per million. A contributing

<sup>2.</sup> All numbers have been rounded.

<sup>3.</sup> These facilities use a Perc-containing brake cleaner which shows a Perc content range from 65% to 94% by weight on the Material Safety Data Sheet (MSDS); therefore, a range is presented for the potential cancer risk.

<sup>4.</sup> This facility used a brake cleaner with a Perc content range of 1% to 100% by weight according to the MSDS. The potential cancer risk was estimated at Perc content of 100% by weight.

factor to this decrease in risk at the MEIR is the increased "buffer" distance created by the facility fence line or the location of the nearest resident. The distance to the MEIR at these facilities was estimated to range from 25 to 800 meters.

Table IV-2. Summary of Potential Health Impacts at the Maximum Exposed Individual Resident (MEIR) <sup>1</sup>

Facility Type (n=16)	Receptor Dist. <sup>2</sup> (meters)	Individual Cancer Risk (per million)	Acute Hazard Index	Chronic Hazard Index
Service Stn. D	150	0.7	< 0.01	< 0.01
Service Stn. E <sup>3</sup>	800	0.01 to 0.02	< 0.01	< 0.01
Service Stn. L <sup>3</sup>	230	0.2 to 0.3	< 0.02	< 0.01
Fleet G	400	0.5	< 0.01	< 0.01
Fleet H <sup>3</sup>	800	0.01	< 0.01	< 0.01
Fleet I <sup>3</sup>	300	2.2 to 3.2	< 0.02	< 0.02
Dealership M	15	17	< 0.07	< 0.09
Dealership N <sup>4</sup>	400	0.07	< 0.01	< 0.01
Gen. Auto O <sup>3</sup>	90	2.4 to 3.4	<0.1	< 0.02
Gen. Auto Q <sup>3</sup>	75	7.7 to 11	<0.2	< 0.06
Gen. Auto R <sup>3</sup>	45	15 to 22	< 0.06	< 0.2
Gen. Auto T	30	30	< 0.07	< 0.2
Gen. Auto U <sup>3</sup>	90	4.1 to 6.0	< 0.03	< 0.03
Gen Auto V 5	6	>0.5	>0.02	>0.1
Brake Shop P <sup>3</sup>	25	6.7 to 9.7	< 0.04	< 0.04
Brake Shop S	460	0.08	< 0.01	< 0.01

<sup>1.</sup> All numbers have been rounded.

<sup>2.</sup> The distance listed here is the estimated distance away from the outside edge of the building to the MEIR.

These facilities use a Perc-containing brake cleaner which shows a Perc content range from 65% to 94% by weight on the Material Safety Data Sheet (MSDS); therefore, a range is presented for the potential cancer risk.

<sup>4.</sup> This facility used a brake cleaner with a Perc content range of 1% to 100% by weight according to the MSDS. The potential cancer risk was estimated using 100% by weight Perc.

<sup>5.</sup> The MEIR is located closer than 20 meters to the center of the volume source, which is the minimum distance modeled; therefore, the potential health impacts are likely to be greater than those listed here. However, we do not anticipate that the potential health impacts will be significant. The impacts shown here are at the near-source location of 20 meters.

The potential risk at the MEIW for the 16 brake service facilities is presented in Table IV-3. At two of these facilities, the potential cancer risk at the MEIW is greater than 10 chances per million. At facility T (general automotive repair), the MEIW potential risk could be in excess of 22 chances per million because of the MEIW's close proximity to facility T. At the general automotive repair facility R, the potential risk at the MEIW ranges from 10 to 15 chances per million. The potential risk at the MEIW for other 14 facilities was estimated to be less than approximately 9 chances per million. The distance to the MEIW at these facilities was estimated to range from 20 to 300 meters. Using guidance from OEHHA, the exposure period of an off-site worker was adjusted to allow for a shorter working lifetime and a shorter operating schedule. This first adjustment is made to allow for a shorter working lifetime, 46 years, rather than a 70-year exposure lifetime which is assumed for residential exposure. The second adjustment is appropriate only when the operating schedule of the off-site facility does not coincide with, or is shorter than, that of the facility being assessed (OEHHA, 1997).

#### b. <u>Summary of Non-cancer Impacts</u>

From the site visits, the modeling results and hazard index estimates show that it is unlikely for significant acute or chronic non-cancer health effects to result from the emissions of Perc from these facilities. For receptor distances greater than 20 to 30 meters from the center of the volume source (building), both the chronic and acute hazard indices are less than 0.6 at near-source, MEIR, and MEIW locations (see Tables IV-1, IV-2 and IV-3). Generally, hazard indices less than 1.0 are not considered to be a concern to public health.

#### 4. What factors at the facility affect the outcome of the risk assessment?

Factors that affect the outcome of potential health impacts at a facility are:

1) the consumption, including use and professional practices, of Perc-containing brake cleaners;

2) the Perc content of the brake cleaner (ranges from 1% to 100%);

3) the facility operating schedule; and 4) the size and release characteristics of the facility. The combination of these factors will ultimately determine the potential impact. Due to the variability of these factors, the potential health impact may either increase or decrease. However, if only the Perc content were to increase, and all other factors were held constant, the resulting potential health impacts would also increase.

Table IV-3. Summary of Potential Health Impacts at the Maximum Exposed Individual (Off-site) Worker (MEIW) <sup>1</sup>

Facility Type (n=16)	Receptor Dist. <sup>2</sup> (meters)	Individual Cancer Risk (per million) <sup>3</sup>	Acute Hazard Index	Chronic Hazard Index
Service Stn. D	30	1.6	< 0.04	< 0.02
Service Stn. E <sup>4</sup>	35	0.4 to 0.6	< 0.09	< 0.01
Service Stn. L <sup>4</sup>	25	1.4 to 2.0	<0.3	< 0.03
Fleet G	30	3.7	< 0.02	< 0.04
Fleet H <sup>4</sup>	300	0.02 to 0.03	< 0.01	< 0.01
Fleet I <sup>4</sup>	300	0.6 to 0.8	< 0.02	< 0.02
Dealership M	20	8.4	< 0.06	< 0.08
Dealership N 5	110	0.30	< 0.01	< 0.01
Gen. Auto O <sup>4</sup>	20	5.0 to 7.3	<0.4	< 0.07
Gen. Auto Q <sup>4</sup>	60	5.3 to 7.7	<0.2	< 0.07
Gen. Auto R <sup>4</sup>	30	10 to 15	< 0.08	< 0.2
Gen. Auto T <sup>6</sup>	5	>22	>0.2	>0.4
Gen. Auto U <sup>4</sup>	65	2.5 to 3.6	< 0.04	< 0.05
Gen Auto V	20	0.23	< 0.02	< 0.01
Brake Shop P 4	30	2.3 to 3.3	< 0.03	< 0.04
Brake Shop S	40	1.2	< 0.01	< 0.02

<sup>1.</sup> All numbers have been rounded.

<sup>2.</sup> The distance listed here is the estimated distance from the outside edge of the building to the MEIW.

Where appropriate, the potential risk estimates are adjusted for a working lifetime of 46 years and to allow for an operating schedule at an offsite facility that does not coincide with, or is shorter than, that of the facility being assessed.

These facilities use a Perc-containing brake cleaner which shows a Perc content range from 65% to 94% by weight on the Material Safety Data Sheet (MSDS); therefore, a range is presented for the potential cancer risk.

This facility used a brake cleaner with a Perc content range of 1% to 100% by weight according to the MSDS. The potential cancer risk was estimated at a Perc content of 100% by weight.

<sup>6.</sup> The MEIW is located closer than 20 meters to the center of the volume source, which is the minimum distance modeled; therefore, the potential health impacts are likely to be greater than those listed here. However, we do not anticipate the potential cancer risk will be greater than 51 chances per million due to worker adjustments discussed in note 3, nor do we anticipate significant non-cancer hazard indices. The impacts shown here are at the near-source location of 20 meters.

#### V. RECOMMENDATIONS

Our findings to date indicate that about one third of the automotive brake cleaning products sold in California each year contain Perc. The Perc-containing products account for about four million pounds of Perc used in California. This represents a substantial increase over previous studies and is significant relative to the total amount of Perc used in California. While it does not appear as if there has been a substantial increase in Perc use since November 1996, some manufacturers have indicated to us that they do plan to reformulate some of their products to contain Perc; however, we do not have sufficient data to allow us to quantify this increase.

We found, based on screening level risk assessments, that some facilities using brake cleaning products that contain Perc may pose a significant carcinogenic health risk to the public. This is based on a significant risk level of 10 chances in a million that the districts use to require facilities to notify the public pursuant to the requirements of the AB 2588 "Hot Spots" program. The screening level risk assessments also indicated that it is unlikely for significant acute or chronic non-cancer health effects to result from the emissions of Perc from these facilities. However, these health risk assessments were based on visits to a limited number of facilities and may not be representative of all brake cleaning operations. Note also that there are many facilities that do not use Perc-containing brake cleaning products and therefore will not pose a risk to the public.

Based on these findings, we recommend that the Board direct us to continue our investigation into the use of Perc in automotive brake cleaning products. The investigation will include the following actions:

- 1. Complete the "Brake Cleaner and Perc-Containing Automotive Products Survey." As noted, we received only 22 of the 37 surveys sent to brake cleaning product manufacturers. Consequently, we will continue our efforts to collect data from all of the manufacturers to ensure that we have as complete a database as possible.
- 2. **Conduct a comprehensive survey of brake cleaning facilities in California.** The survey will identify: 1) the number of automotive repair facilities that perform brake service operations; 2) the number of facilities currently using Perc-containing brake cleaning products; and 3) the amount of Perc used at individual brake service facilities. Additionally, the survey will identify source characteristics and other information necessary to determine both localized impacts and impact on statewide risk.
- 3. **Assess the potential for increased Perc use due to product reformulation.** We propose gathering additional information from the brake cleaner manufacturers and brake service facility operators regarding the number of products that are being reformulated because the products contain TCA or do not comply with the 50 percent VOC limit set by the Consumer Products Regulation. Note that the manufacturers will be submitting annual reports on Perc usage pursuant to the Consumer Products Regulation.

- 4. **Investigate the cost and efficacy of potential alternatives to Perc-containing brake cleaning products.** We propose working with the manufacturers, the brake service industry, and others to investigate the cost and efficacy of potential alternatives to brake cleaning products containing Perc. This would be a critical component of any proposed control action.
- 5. **Identify the most effective control options to address potential risk.** Based on the findings to date and the data collected as part of this investigation, there are likely to be facilities that may pose a significant health risk to the public. Consequently, it is important to begin assessing the most effective ways to reduce this risk. Initial options include developing an airborne toxic control measure to limit the amount of Perc in the products, or addressing individual facility risk through the AB 2588 "Hot Spots" program.
- 6. **Develop appropriate educational materials for brake service facility operators to reduce potential risk.** We propose to work with affected parties to develop and distribute to brake service facility operators an advisory on the use of Perc-containing brake cleaning products. The advisory will contain information about the potential health effects from the use of these products, the alternatives or substitute solvents that are available to reduce adverse health impacts, the cost impact to the facility operators, and other environmental benefits that can result from the use of alternatives or substitute solvents.
- 7. Continue the outreach program to ensure that there is adequate opportunity for public input into the investigation. We propose to continue an aggressive outreach program to seek public input and ensure that we are obtaining the best data on which to base our recommendations and addressing significant concerns and issues.

The information that has been collected suggests that the development of an ATCM may be appropriate. Many of the actions listed above will allow staff to obtain the information needed if we develop an ATCM for Perc-containing brake cleaning products. However, we do not believe that we have sufficient information on available solvent alternatives, substitutes, and potential health impacts. We expect to complete our investigation by early Spring 1998, and will have sufficient information to determine if a statewide ATCM is warranted for Perc-containing brake cleaning products. We will report back to the Board on our findings and recommendations at that time.

#### REFERENCES

- ARB, 1991. <u>Initial Statement of Reasons for Rulemaking Staff Report/Executive Summary, Proposed Identification of Perchloroethylene as a Toxic Air Contaminant, California Air Resources Board, August 1991.</u>
- ARB, 1993. <u>Technical Support Document: Proposed Airborne Toxic Control Measure And Proposed Environmental Training Program for Perchloroethylene Dry Cleaning Operations</u>, California Air Resources Board, August 1993.
- ARB, 1996. <u>Curriculum for the Environmental Training Program for Perchloroethylene Dry Cleaning Operations</u>, California Air Resources Board, August 1996.
- BAR, 1997. Telephone conversation with Rob Oglesby, California Department of Consumer Affairs, Bureau of Automotive Repair, and Tina Najjar on March 13, 1997.
- BOE, 1997a. Fax received March 5, 1997 from the Board of Equalization office in Sacramento.
- BOE, 1997b. Telephone conversation with Wun-Chi Wang, Board of Equalization, and Mark Williams on March 5, 1997.
- CAPCOA, 1993. <u>CAPCOA Air Toxics "Hot Spots" Program Revised 1992 Risk</u>
  <u>Assessment Guidelines</u>, Toxics Committee of the California Air Pollution Control Officer Association (CAPCOA), October 1993.
- Norton, 1993. "Usage of Chemical Brake Cleaners in Automotive Repair Facilities", John Norton, School of Business Administration, George Mason University, Fairfax, VA, November 8, 1993.
- OEHHA, 1997. Telephone conversation with Melanie Marty, Manager, Air Risk Assessment Unit, Office of Environmental Health Hazard Assessment, and Greg Harris on May 1, 1997.
- U.S. Economic Census, 1992. <u>Government Information Sharing Project, Information Services, Oregon State University, Internet Site: http://govinfo.kerr.orst.edu/</u>, March 5, 1997.
- U.S. EPA 1990 Database. United States Environmental Protection Agency (U.S. EPA) 1990 Consumer and Commercial Products Database, collected pursuant to the 1990 Amendments to the Federal Clean Air Act.

U.S. EPA, 1995. <u>SCREEN3 Model User's Guide</u>, EPA-454/B-95-004, United States Environmental Protection Agency (U.S. EPA), Research Triangle Park, North Carolina, September 1995.

#### Appendix A

**Brake Cleaner and Perc-Containing Automotive Products Survey** 

## California Environmental Protection Agency Air Resources Board

## INSTRUCTIONS FOR COMPLETING THE BRAKE CLEANER AND PERC-CONTAINING AUTOMOTIVE PRODUCTS SURVEY

#### **GENERAL INSTRUCTIONS**

- Please type or print legibly in ink when filling out the survey form.
- Please review the instructions and the survey form prior to filling out the form.
- We suggest that you make extra copies of the form.
- If you have any questions on the survey or the information we have requested, please contact Mark Williams of the Air Resources Board (ARB) staff at (916) 327-5633.
- In order to get accurate data from this survey, we would appreciate it if you would consult your actual sales records for determining California sales.
- In filling out the survey form if you encounter any questions which do not apply in your situation, please enter "N/A" in the appropriate blanks.
- If you wish to clarify the information supplied by your company or would like to make additional comments, please use Section V to enter your comments. In clarifying the information your company has supplied, please refer to the appropriate table, column, and row or product name.

#### SECTION I. COMPANY INFORMATION

**Company Name:** Enter the entire company name.

**Division Name:** If the respondent to the survey is representing a division of the

company please enter the division name. If the respondent to the survey is representing several divisions being reported under one company, please enter the additional division names in Section IV:

Other Information at the end of the survey.

**Contact Person:** Enter the name of the person to be contacted by the ARB if

clarifications are needed.

**Address:** Enter the mailing address of the company or division responsible for

completing the survey.

**Manufacturer**/ Check the corresponding box to indicate whether you are a

**Distributor:** manufacturer or a distributor or both.

**Phone/Fax Number:** Enter the phone and fax numbers of the contact person.

**Confidential** If you would like us to treat this information and data in a confidential

**Information:** manner, please check the box at the bottom of Section I.

**E-mail Address:** Enter the E-mail address of the contact person, if available.

#### SECTION II. BRAKE CLEANER PRODUCT INFORMATION

#### Column

#### Instructions

- 1, 8: List all of the products that your company either makes, formulates, fills for another company, or distributes. After having listed all the applicable products in column 1 of Section II., copy the product names in column 8 of the continuation section (Section II.) at the foot of the page. Be sure to list them in the same order.
- 2: For those products which you either fill for another company, or distribute, please list the manufacturer's name in Section V, Other Comments.
- 3: Enter the product form as either (A)erosol, (L)iquid, (P)ump spray, (G)el, (S)olid, or (O)ther. If the product falls into the "Other" category, please specify the form in Section V, Other Comments.
- 4: What is the weight (ounces) of the product in the container or dispenser? If the product comes in more than one size, list the different sizes as separate entries. It is permissible to report the product size in fluid ounces or gallons, but we request that you enter either the product density in grams per milliliter (g/ml) or its specific gravity (see Section III.).
- 5-7: What is the number of units of product sold or distributed in California (column 5)? If there are multiple sizes, list the number of units sold or distributed for each size. We are also interested in who the end users are. What percentage of the units are sold for industrial use in shops which do automotive brake repair and servicing (column 6)? What percentage of the units are sold through a retail store for individual or home use (column 7)?
- 9: Write in the percentage of Perc by weight contained in the product. If this is a non-chlorinated product, please list the main ingredients in Section V, Other Comments.
- 10: Does the product meet the Volatile Organic Compound (VOC) limit of 50 percent content by weight as required by Article 2 of the Consumer Products Regulation? (Title 17, California Code of Regulations, Section 94509)
- 11-13: These columns deal with product reformulation. In column 11, please enter whether your company intends to reformulate the product by simply answering "yes" or "no". In column 12 we would like you to enter an estimated date when the product will be reformulated, if applicable. This date would be when the product is estimated to be sold as a commercial product. If the product is to be reformulated, please enter whether the Perc content will increase as a result of the reformulation along with an estimate of what the new Perc content (percent weight) will be (column 13).

#### SECTION III. LIQUID BRAKE CLEANERS

#### Column Instructions

- 1: Enter any products from Section II. which come in liquid form. These products would be those where "L" is entered in column 3 of Section II.
- 2: What is the volume (fluid ounces or gallons) of the product in the container or dispenser? If the product comes in more than one size, list the different sizes as separate entries. Please note that we are asking for the amount of product measured by volume, and not by weight as was requested in column 4 of Section II.
- 3: Please enter either the product density in grams per milliliter (g/ml) or its specific gravity.
- 4: After product purchase for industrial or home use, does the product need to be diluted prior to its use or application?
- 5,6: If the producted is diluted, what is the recommended amount of product (column 5) for the given amount of diluent (column 6) per the container instructions? Please specify whether the amounts are given in terms of volume or weight and the units.
- 7: If the product is diluted, what is the recommended diluent per the instructions?

#### SECTION IV. OTHER AUTOMOTIVE PRODUCTS CONTAINING PERC

#### <u>Column</u> <u>Instructions</u>

- 1: This column lists other products which could contain Perc.
- 2: Please answer "Yes" or "No" in the blank by each product category whether your company manufactures, formulates, fills, or distributes that type of product. For those products which you either fill for another company, or distribute, please list the manufacturer's name in Section V, Other Comments.
- 3: If you answered yes in column 2 to any of the product categories, please answer whether the product(s) contain Perc?
- 4-6: These columns deal with product reformulation. In column 4, please enter whether your company intends to reformulate the product by simply answering "yes" or "no". In column 5 we would like you to enter an estimated date when the product will be reformulated, if applicable. This date would be when the product is estimated to be sold as a commercial product. If the product is to be reformulated, please enter whether the Perc content will increase as a result of the reformulation along with an estimate of what the new Perc content (percent weight) will be (column 6).

#### SECTION V. OTHER COMMENTS

If you wish to clarify the information you have supplied or make additional miscellaneous comments on the survey, please enter the comments in this box. In clarifying the information your company has supplied, please refer to the appropriate table, column and row or product name.

#### BRAKE CLEANER AND PERC-CONTAINING AUTOMOTIVE PRODUCTS SURVEY

(Please use extra sheets if necessary)

#### SECTION I. COMPANY INFORMATION

COMPANY NAME				ADDRESS			
DIVISION NAME							
CONTACT PERSON		CITY		STATE	ZIP		
MANUFACTURER?		DISTRIBUTOR?		PHONE (	)	FAX ( )	
CHECK THE BOX IF THIS INFORMATION IS <b>CONFIDENTIAL</b> ? $\Box$				E-MAIL ADDI	RESS		

#### SECTION II. BRAKE CLEANER PRODUCT INFORMATION (Please see attached instructions)

COLUMN 1	2	3	4	5	6	7
PRODUCT NAME	OWN PRODUCT LINE?	FORM	NET SIZE (Weight in ounces)	UNITS SOLD IN CALIFORNIA	INSTITUTIONAL/ INDUSTRIAL SALES (%)	RETAIL/ HOUSEHOLD SALES (%)

#### SECTION II. BRAKE CLEANER PRODUCT INFORMATION (Continued)

COLUMN 8	9	10	11	12	13
PRODUCT NAME	PERC CONTENT (Weight percent)	MEETS 50% VOC LIMIT?	WILL PRODUCT BE REFORMULATED	ESTIMATED REFORMULATION DATE	WILL PERC CONTENT INCREASE WITH REFORMULATION?

#### SECTION III. BRAKE CLEANER PRODUCT INFORMATION (For liquids only)

COLUMN 1	2	3	4	5	6	7
PRODUCT NAME	NET SIZE (Fluid oz. or gallons)	DENSITY(g/ml)/ SPECIFIC GRAVITY	I S THE PRODUCT DILUTED?	AMOUNT OF PRODUCT	AMOUNT OF DILUENT	TYPE OF DILUENT

#### SECTION IV. OTHER AUTOMOTIVE PRODUCTS CONTAINING PERC

COLUMN 1	2	3	4	5	6
PRODUCT CATEGORY	DO YOU MANUFACTURE A PRODUCT IN THIS CATEGORY?	DOES IT CONTAIN PERC?	WILL THE PRODUCT BE REFORMULATED?	ESTIMATED REFORMULATION DATE	WILL PERC CONTENT INCREASE WITH REFORMULATION?
Brake Anti-squeal compounds					
Bug and tar removers					
Carburetor and choke cleaners					
Engine Degreasers					
Lubricants (excluding engine oil)					
Penetrants					
Undercoatings					
Upholstery fabric cleaners					

SECTION V.	OTHER COMMENTS

#### CONFIDENTIAL INFORMATION SUBMITTAL FORM

If you wish to designate any information contained in your survey data as **CONFIDENTIAL INFORMATION**, please provide the data requested below and return it with your completed survey form.

In accordance with Title 17, California Code of Regulations (CCR), Section 91000 to 91022, and the California Public Records Act (Government Code Section 6250 et seq.), the information that a company provides to the Air Resources Board (ARB) may be released (1) to the public upon request, except trade secrets which are not emissions data or other information which is exempt from disclosure or the disclosure of which is prohibited by law, and (2) to the Federal Environmental Protection Agency (EPA), which protects trade secrets as provided in Section 114(c) of the Clean Air Act and amendments thereto (42 USC 7401 et seq.) and in federal regulation, and (3) to other public agencies provided that those agencies preserve the protections afforded information which is identified as a trade secret, or otherwise exempt from disclosure by law (Section 39660(e)).

Trade secrets as defined in Government Code Section 6254.7 are not public records and therefore will not be released to the public. However, the California Public Records Act provides that air pollution emission data are always public records, even if the data comes within the definition of trade secrets. On the other hand, the information used to calculate information is a trade secret.

If any company believes that any of the information it may provide is a trade secret or otherwise exempt from disclosure under any other provision of law, it must identify the confidential information as such at the time of submission to the ARB and must provide the name address, and telephone number of the individual to be consulted, if the ARB receives a request for disclosure or seeks to disclose the data claimed to be confidential. The ARB may ask the company to provide documentation of its claim of trade secret or exemption at a later date. Data identified as confidential will not be disclosed unless the ARB determines, in accordance with the above referenced regulations, that the data do not qualify for a legal exemption from disclosure. The regulations establish substantial safeguards before any such disclosure. In accordance with the provisions of Title 17, California Code of Regulations, Section 91000 to 91022, and the California Public Records Act (Government Code Sections 6250 et seq.), **Company Name:** declares that all the information submitted in response to the California Air Resources Board's information request on the brake cleaner and perc-containing automotive products survey is confidential "trade secret" information, and request that it be protected as such from public disclosure. All inquiries pertaining to the confidentiality of this information should be directed to the following person: Date: Mailing Address: (Signature) (Printed Name) (Title)

Revised March 26, 1997 A-7 SSD/EAB/MDW

(Telephone Number)

## Appendix B

**Brake/Automotive Repair Shop Survey** 

# California Environmental Protection Agency Air Resources Board

#### **BRAKE/AUTOMOTIVE REPAIR SHOP SURVEY**

Facility:		
Address:		
Contact: Title:		
Phone #: Regional Manager		
SHOP DESCR		
The approximate dimensions of the entire shop area, include storage and other areas not partitioned off as all connecting structures. (If attached to a strip mall of	separate rooms.	Exterior dimensions include
Interior Height, Width	, Length	
Exterior Height, Width	, Length	
Type(s) of ventilation used:  Wall fan $\square$ Ceiling or exhaust fan $\square$ open doo	rs 🗖 other	
	Nominal 1	Dimensions (include units)
Number and ave. size of servicing bays:	Nominal	Dimensions (include units)  W
Number and ave. size of servicing bays:	Nominal   L H	Dimensions (include units) W W
Number and ave. size of servicing bays:	Nominal   L  H  H	Dimensions (include units) W W
Number and ave. size of servicing bays:	Nominal   L H H H	Dimensions (include units)  W W W

#### **SHOP DESCRIPTION (continued)**

Are ventilation practices different between mild and inclement weather? Explain:
OPERATION DESCRIPTION
Number of employees:
Average number of employees in service area each day:
Number of people performing brake services each day:
Number of automotive services performed per week:
Number of automobiles requiring brake work per week:
Number of axles serviced per week:
Types of brake services performed:
Comments:
PRODUCT INFORMATION
Number of different brake cleaning product(s) used:
Has the shop used any other type of brake cleaner? If so, what type of product was used? What was the outcome? Is there a preference of the type of product used?
If an aqueous type product is used, please list shop's reasons for using product (i.e. product cheaper, etc.)
If an aqueous product is used, has drying time been a concern in the brake repairs? (Explain)
Where are the brake parts cleaned?
On the vehicle $\square$ Off the vehicle $\square$ On and off the vehicle $\square$
When the brake parts are cleaned with an aerosol, are the parts at:
Floor level $\square$ Eye level $\square$ Bench level $\square$
If used, what is the approximate fate of all Perc usage (e.g. 50% air, 40% reclaimed for proper disposal, 9% sewer, 1% storm drain)

#### **PRODUCT INFORMATION (continued)**

Ask for a unit of the product(s) used to inspect the label; copy the following information: 1. Product name: Manufacturer: Address:\_\_\_\_\_\_ Phone #:\_\_\_\_\_ size:\_\_\_\_\_\_ (fl oz., wt oz, gal.) Code date:\_\_\_\_\_ Product form: Aerosol □ Liquid □ Pump Spray □ Other Active ingredients: % Perc:\_ Usage (application) information: Does the product require dilution (Y / N)Dilute \_\_\_\_\_ of product into \_\_\_\_\_ (amount product) (units) (amount diluent) of Apply with \_\_\_\_\_\_ (application equipment used, wipe, spray bottle, etc.) (diluent used) Number of product units used per week by facility\_\_\_\_\_ Volume of diluted product used in a week Is the product used for any other application other than brakes? If so what other applications is it used for (i.e. general degreasing, etc.):\_\_\_\_\_ How often and how much of the product used for other purposes:\_\_\_\_\_ (give time frame and amount used) Did you see a demonstration of the product in use?\_\_\_\_\_

#### **PRODUCT INFORMATION (continued)**

Ask for a unit of the product(s) used to inspect the label; copy the following information: 2. Product name: Manufacturer: Address:\_\_\_\_\_\_ Phone #:\_\_\_\_\_ size:\_\_\_\_\_\_ (fl oz., wt oz, gal.) Code date:\_\_\_\_\_ Product form: Aerosol □ Liquid □ Pump Spray □ Other Active ingredients: % Perc:\_ Usage (application) information: Does the product require dilution (Y / N)Dilute \_\_\_\_\_ of product into \_\_\_\_\_ (amount product) (units) (amount diluent) of Apply with \_\_\_\_\_\_ (application equipment used, wipe, spray bottle, etc.) (diluent used) Number of product units used per week by facility\_\_\_\_\_ Volume of diluted product used in a week Is the product used for any other application other than brakes? If so what other applications is it used for (i.e. general degreasing, etc.):\_\_\_\_\_ How often and how much of the product used for other purposes:\_\_\_\_\_ (give time frame and amount used) Did you see a demonstration of the product in use?\_\_\_\_\_

#### **PRODUCT INFORMATION (continued)**

Ask for a unit of the product(s) used to inspect the label; copy the following information: Product name: 3. Manufacturer: Address:\_\_\_\_\_\_ Phone #:\_\_\_\_\_ size:\_\_\_\_\_\_ (fl oz., wt oz, gal.) Code date:\_\_\_\_\_ Product form: Aerosol □ Liquid □ Pump Spray □ Other Active ingredients: % Perc:\_ Usage (application) information: Does the product require dilution (Y / N)Dilute \_\_\_\_\_ of product into \_\_\_\_\_ (amount product) (units) (amount diluent) of Apply with (application equipment used, wipe, spray bottle, etc.) (diluent used) Number of product units used per week by facility\_\_\_\_\_ Volume of diluted product used in a week Is the product used for any other application other than brakes? If so what other applications is it used for (i.e. general degreasing, etc.):\_\_\_\_\_ How often and how much of the product used for other purposes:\_\_\_\_\_ (give time frame and amount used) Did you see a demonstration of the product in use?\_\_\_\_\_

General comments/observations:

# Appendix C

**Summary of the Different Types of Brake Service Facilities** 

# **Appendix C.** Summary of the Different Types of Brake Service Facilities

Based on information from the California Board of Equalization, the California Department of Consumer Affairs' Bureau of Automotive Repair, and the United States Economic Census, we have grouped brake service facilities into five general categories: service stations, fleets, car dealerships, brake shops, and general automotive repair facilities. Table C-1 lists the five facility categories and summarizes the average number of vehicles serviced per week and the average number of brake services performed per week for each category based on the site visit data.

Table C-1. Summary of Brake Service Facility Categories

Facility Category	Description	Average Number of Vehicles Serviced Per Week <sup>1</sup>	Average Number of Brake Services Per Week <sup>1</sup>	
Service Stations	Offer automotive repair services where gasoline and other fuels can be purchased. These facilities repair mainly passenger and light-duty vehicles and operate service areas 40 to 60 hours per week.	57	3	
Fleets	Governmental agencies and private companies operate fleets of vehicles ranging from passenger cars to heavy-duty trucks and buses. Fleet centers encompass a large area which limit how close offsite receptors can be located. These facilities operate 40 to 50 hours per week and may include shift schedules.	117	23	
New and Used Car Dealerships	Many new and used car dealerships offer a complete range of brake repair services in addition to other automotive repair services. Their services are not limited to customers who purchased a vehicle from them.	334	40	
Brake shops	Some shops limit their services to brake service activities although additional repair services are often available.	120	20	
General Automotive Repair	Includes independently-owned shops, franchises, chain shops, tire replacement and repair shops, and passenger car and truck rental and leasing.	79	10	

<sup>1.</sup> Numbers are based on survey data collected from ARB site visits and do not represent a generic facility.

# Appendix D

**Health Effects and Example Risk Assessment Calculations** 

#### Appendix D. Health Effects and Example Risk Assessment Calculations

This appendix is divided into four sections and covers the following topics:

- a summary of the air dispersion modeling and potential health impacts at the facilities that were modeled:
- an example calculation of a facility's potential health impacts;
- a discussion of the SCREEN3 model; and
- tables presenting the modeling input parameters, modeling results, and potential health impacts for each facility modeled.

The information presented is for the 16 facilities that staff visited and found using Perc-containing brake cleaners. These 16 facilities are a subset of the 37 brake service facilities where ARB staff has conducted site visits. The other 21 facilities were not assessed because they did not use Perc-containing products. The ARB staff plan to visit additional facilities to obtain a larger sampling of facility source characteristics and usage practices.

#### A. Summary of the Air Dispersion Modeling and Potential Health Impacts

#### 1. <u>Air Dispersion Modeling</u>

The ARB staff used the SCREEN3 air dispersion model, version 96043, to estimate potential ground-level concentrations due to Perc emissions from the brake service facilities. The U.S. EPA recommends the SCREEN3 model for air dispersion modeling and it is currently used by the ARB, districts, and other states (U.S. EPA, 1995). Each of the 16 facilities were modeled as a volume source in simple urban terrain, using the operating schedule reported by the facility operator.

The Perc emission releases from brake service operations are intermittent and quasi-puff-like when they leave the facility. The SCREEN3 model assumes a continuous release source on an hourly basis. Distributing the emissions over the operating schedule will provide similar results to a puff-like air dispersion model. These results will be similar because the acute concentration averaging time is much longer than the release time (an hour as opposed to seconds) and the maximum concentration occurs in the near field (within hundreds of meters). The SCREEN3 model also has the advantage of being much easier to use. See section C of this appendix for more information on the selection of the SCREEN3 model.

Default meteorological data, which is included in SCREEN3, was utilized to give a estimated maximum 1-hour concentration for determining potential acute non-cancer health impacts. SCREEN3 was also run a second time to provide an annualized maximum one hour concentration which is used when determining potential chronic non-cancer impacts and cancer risk. Default meteorological data are intended to represent worst-case meteorological conditions

and are commonly used in a screening level air dispersion analysis. A factor of 0.08 was used to convert from an annualized maximum 1-hour concentration to an annual average concentration (U.S. EPA, 1992). In addition to the U.S. EPA conversion factor, the maximum annual average concentration is discounted by the operating schedule to allow for the hours the facility does not emit (see section B of this appendix).

Due to limitations in Gaussian-based models such as the SCREEN3 model, we selected a minimum receptor distance of 20 to 30 meters from the center of the volume source, which we assumed to be the center of the building. For the 16 facilities modeled, 20 to 30 meters from the center of the building corresponds to an approximate distance of 2 to 16 meters away from the outside edge of the building.

The 16 facilities modeled include three fleet facilities, three service stations, two car dealerships, six general automotive facilities, and two brake shops. In summary, the Perc concentrations at two of the facilities may be in excess of the near-source concentrations because there are receptors at these facilities that are closer than the minimum modeled distance of 20 meters. However, we do not anticipate that the resulting potential health impacts will be significantly different than they are at 20 meters. The Perc concentrations from the other 14 facilities are lower at the maximum exposed individual resident (MEIR) and the maximum exposed individual worker (MEIW) than near-source locations. A contributing factor to this decrease in concentrations is the increased distance between the edge of the building and the facility fence line or actual residential or off-site worker locations. The modeling results indicate that estimated concentrations can range from less than 2 meters to approximately 170 times higher near the edge of the building which is the location of maximum concentration (see Tables D-1, D-2, and D-3).

# 2. <u>Potential Health Impacts</u>

Table D-1 summarizes the maximum potential cancer and non-cancer health impacts. The maximum potential health impacts are estimated to occur at near-source locations. For these 16 facilities, we selected a minimum receptor distance of 20 to 30 meters from the center of the volume source or building to define a near-source location. The purpose of estimating the potential health impacts at a near-source location is to illustrate what the potential health impacts can be if a receptor was located close to the facilities which were assessed, rather than having an increased "buffer" distance between the receptor and the edge of the building. Tables D-2 and D-3 summarize the potential cancer and non-cancer health impacts at the MEIR and MEIW, respectively.

#### a. <u>Summary of Carcinogenic Impacts at a Near-source Location</u>

From a carcinogenic standpoint, the near-source risk assessment results for the 16 facilities range from approximately 0.3 to 51 chances in a million. The individual results are presented in Table D-1. Eight of the facilities assessed have near-source potential cancer risks

that are greater than 10 chances per million. At fleet facility I, the potential near-source cancer risk ranges from approximately 33 to 47 chances per million at 20 meters from the center of the volume source (building). At dealership M, the potential near-source cancer risk is approximately 19 chances per million. At the general automotive facilities O, Q, R, T, and U, the potential near-source cancer risk ranges from approximately 11 to 51 chances per million. At brake shop P, the near-source potential cancer risk ranges from approximately 8.8 to 13 chances per million. At these facilities, the distances from the edge of the building to the near-source location range from approximately 9 to 15 meters (see Table D-1).

At the other eight facilities, the near-source potential cancer risks are all below 10 chances per million. Of these eight, the two remaining fleet facilities' potential cancer risk ranges from approximately 0.3 to 9 chances per million and the three service stations' potential cancer risk ranges from approximately 2 to 8 chances per million. Brake Shop S had a potential cancer risk of approximately five chances per million. Dealership N had a potential cancer risk of approximately 4 chances per million and General Automotive Facility V had a potential cancer risk of less than one chance per million (see Table D-1). For these eight facilities, the potential near-source cancer risk impacts were estimated at 20 to 30 meters from the center of the volume source.

## b. <u>Summary of Carcinogenic Impacts at the MEIR</u>

The risk assessment results for the MEIR are presented in Table D-2. At four of these facilities, the potential cancer risk at the MEIR is greater than 10 chances per million. At dealership M, where the MEIR is located approximately 15 meters away from the outside edge of the building, the potential cancer risk is approximately 17 chances per million. At the general automotive facilities Q, R, and T, the potential MEIR risk ranges from approximately 8 to 30 chances per million for receptors ranging from 30 to 75 meters away from the outside edge of the building.

At the other 12 facilities, the potential risk at the MEIR ranges from approximately 0.01 to 10 chances per million (see Table D-2). A contributing factor to this decrease in risk at the MEIR is the increased "buffer" distance created by the facility fence line or the location of the nearest resident. The distance to the MEIR at these facilities was estimated to range from 25 to 800 meters.

#### c. <u>Summary of Carcinogenic Impacts at the MEIW</u>

The potential risk at the MEIW for the 16 brake service facilities is presented in Table D-3. At two of these facilities, the potential cancer risk at the MEIW is greater than 10 chances per million. At facility T (general automotive), the MEIW potential risk could be in excess of 22 chances per million because of the MEIW's close proximity to the facility. At the general automotive facility R, the potential risk at the MEIW ranges from 10 to 15 chances per million. The potential risk at the MEIW for other 14 facilities was estimated to be less than

approximately 9 chances per million. The distance to the MEIW at these facilities was estimated to range from 20 to 300 meters. Using guidance from OEHHA, the exposure period of an off-site worker was adjusted to allow for a shorter working lifetime and a shorter operating schedule. This first adjustment is made to allow for a shorter working lifetime, 46 years, rather than a 70-year exposure lifetime which is assumed for residential exposure. The second adjustment is appropriate only when the operating schedule of the off-site facility does not coincide with, or is shorter than, that of the facility being assessed (OEHHA, 1997).

#### d. <u>Summary of Non-cancer Impacts</u>

From the site visits, the modeling results and hazard index estimates show that it is unlikely for significant acute or chronic non-cancer health effects to result from the emissions of Perc from these facilities. For receptor distances greater than 20 to 30 meters from the center of the volume source (building), or greater than 2 to 16 meters away from the outside edge of the building, both the chronic and acute hazard indices are less than 0.6 at the near-source, MEIR, and MEIW locations (see Tables D-1, D-2 and D-3). Generally, hazard indices less than 1.0 are not considered to be a concern to public health.

Table D-1. Summary of Near-Source Modeling and Potential Health Impacts<sup>1,2</sup>

Facility Type (n=16)	Receptor Dist. 3 [meters]	Max. 1-hr Conc. (Acute) <sup>4</sup> [μg/m³]	Max. 1-hr Conc. Annualized <sup>5</sup> [µg/m³]	Annual Avg. Conc. <sup>6</sup> [µg/m³]	Individual Cancer Risk [per million]	Acute Hazard Index	Chronic Hazard Index
Service Stn. D	2	446	50	1.3	7.5	<0.1	< 0.1
Service Stn. E <sup>7</sup>	16	710 to 1026	10.3 to 14.9	0.34 to 0.49	2.0 to 2.9	< 0.2	< 0.1
Service Stn. L <sup>7</sup>	12	1688 to 2439	31 to 45	0.8 to 1.2	4.7 to 6.8	< 0.4	< 0.1
Fleet G	3	263	76.3	1.5	9.1	<0.1	< 0.1
Fleet H 7	2	17.9 to 25.8	2.3 to 3.3	0.05 to 0.07	0.3 to 0.4	<0.1	< 0.1
Fleet I 7	9	972 to 1408	126 to 183	5.5 to 8.0	33 to 47	< 0.3	< 0.3
Dealership M	9	530	162	3.3	19	<0.1	< 0.1
Dealership N <sup>8</sup>	13	102	31	0.6	3.7	< 0.1	< 0.1
Gen. Auto O <sup>7</sup>	12	1956 to 2828	87 to 126	1.9 to 2.7	11 to 16	<0.5	< 0.1
Gen. Auto Q 7	10	2427 to 3509	216 to 312	4.6 to 6.7	27 to 39	<0.6	< 0.2
Gen. Auto R 7	11	593 to 857	242 to 350	5.9 to 8.6	35 to 50	<0.2	< 0.3
Gen Auto T	15	730.7	323	8.7	51	<0.2	< 0.3
Gen Auto U 7	15	519.2 to 750.0	130 to 188	3.7 to 5.3	22 to 32	< 0.2	< 0.2
Gen Auto V 7	15	86.4	3.8	0.08	0.5	<0.1	< 0.1
Brake Shop P 6	15	224 to 324	52 to 76	1.5 to 2.2	8.8 to 12.7	<0.1	< 0.1
Brake Shop S	14	70.62	35	0.8	5.0	<0.1	< 0.1

<sup>1.</sup> Near-source is defined as the modeled minimum receptor distance of 20 to 30 meters from the building center, or ranging from 2 to 16 meters from the edge of the building.

<sup>2.</sup> All numbers have been rounded.

<sup>3.</sup> This distance is the estimated receptor distance away from the outside edge of the building which ranges from approximately 2 to 16 meters.

<sup>4.</sup> Based on maximum 1-hour emission rates. Used for the calculation of potential acute non-cancer hazard indices.

<sup>5.</sup> Based on annualized emission rates. Used when determining potential chronic impacts and cancer risk.

<sup>6.</sup> Annual average concentration are discounted by the operating schedule for the hours the facility does not emit and includes the U.S. EPA conversion factor of 0.08.

<sup>7.</sup> These facilities use a Perc-containing brake cleaner which shows a Perc content range from 65% to 94% by weight on the Material Safety Data Sheet (MSDS); therefore, a range is presented for the modeling results and potential cancer risk.

<sup>8.</sup> This facility used a brake cleaner with a Perc content range of 1% to 100% by weight according to the MSDS. The potential cancer risk was estimated at a Perc content of 100% by weight.

Table D-2. Summary of Modeling and Potential Health Impacts at the Maximum Exposed Individual Resident (MEIR) <sup>1</sup>

Facility Type (n=16)	Receptor Dist. 2 [meters]	Max. 1-hr Conc. (Acute) <sup>3</sup> [μg/m <sup>3</sup> ]	Max. 1-hr Conc. Annualized <sup>4</sup> [μg/m³]	Annual Avg. Conc. <sup>5</sup> [µg/m³]	Individual Cancer Risk [per million]	Acute Hazard Index	Chronic Hazard Index
Service Stn. D	150	40.4	4.5	0.12	0.7	< 0.01	< 0.01
Service Stn. E <sup>6</sup>	800	4.44 to 6.41	0.06 to 0.09	0.002 to 0.003	0.01 to 0.02	< 0.01	< 0.01
Service Stn. L <sup>6</sup>	230	82.9 to 120	1.5 to 2.2	0.04 to 0.06	0.2 to 0.3	< 0.02	< 0.01
Fleet G	400	4.8	4.1	0.08	0.5	< 0.01	< 0.01
Fleet H <sup>6</sup>	800	0.58 to 0.83	0.07 to 0.1	0.0016 to 0.002	0.01	< 0.01	< 0.01
Fleet I 6	300	65.3 to 94.6	8.5 to 12	0.37 to 0.54	2.2 to 3.2	< 0.02	< 0.02
Dealership M	15	457	140	2.8	16.6	< 0.07	< 0.09
Dealership N <sup>7</sup>	400	2.01	0.6	0.01	0.07	< 0.01	< 0.01
Gen. Auto O 6	90	424 to 614	19 to 27	0.40 to 0.58	2.4 to 3.4	<0.1	< 0.02
Gen. Auto Q 6	75	702 to 1015	62 to 90	1.3 to 1.9	7.9 to 11.4	< 0.2	< 0.06
Gen. Auto R 6	45	256 to 370	104 to 151	2.6 to 3.7	15 to 22	< 0.06	< 0.2
Gen Auto T	30	424	187	5.0	30	< 0.07	< 0.2
Gen Auto U 6	90	98.2 to 142	24 to 35	0.7 to 1.0	4.1 to 6.0	<0.08	< 0.03
Gen Auto V 8	6	>86	>3.8	>0.08	>0.5	>0.02	>0.1
Brake Shop P 6	25	171 to 247	40 to 58	1.1 to 1.6	6.7 to 9.7	< 0.04	< 0.05
Brake Shop S	460	1.20	0.6	0.014	0.08	< 0.01	< 0.01

<sup>1.</sup> All numbers have been rounded.

<sup>2.</sup> The distance listed here is the estimated distance away from the outside edge of the building to the MEIR.

<sup>3.</sup> Based on maximum 1-hour emission rates. Used for the calculation of potential acute non-cancer hazard indices.

<sup>4.</sup> Based on annualized emission rates. Used when determining potential chronic impacts and cancer risk.

<sup>5.</sup> Annual average concentration are discounted by the operating schedule for the hours the facility does not emit and includes the U.S. EPA conversion factor of 0.08.

<sup>6.</sup> These facilities use a Perc-containing brake cleaner which shows a Perc content range from 65% to 94% by weight on the Material Safety Data Sheet (MSDS); therefore, a range is presented for the modeling results and potential cancer risk.

<sup>7.</sup> This facility used a brake cleaner with a Perc content range of 1% to 100% by weight according to the MSDS. The potential cancer risk was estimated at a Perc content of 100% by weight.

<sup>8.</sup> The MEIR is located closer than 20 meters to the center of the volume source, which is the minimum distance modeled; therefore, the potential health impacts are likely to be greater than those listed here. However, we do not anticipate that the potential health impacts will be significant. The impacts shown here are at the near-source location of 20 meters.

Table D-3. Summary of Modeling and Potential Health Impacts at the Maximum Exposed Individual (Off-site) Worker (MEIW) 1

Facility Type (n=16)	Receptor Dist. 2 [meters]	Max. 1-hr Conc. (Acute) <sup>3</sup> [μg/m³]	Max. 1-hr Conc. Annualized <sup>4</sup> [µg/m³]	Annual Avg. Conc. <sup>5</sup> [μg/m <sup>3</sup> ]	Individual Cancer Risk <sup>6</sup> [per million]	Acute Hazard Index	Chronic Hazard Index
Service Stn. D	30	206	23	0.6	1.6	< 0.04	< 0.02
Service Stn.E <sup>7</sup>	35	385 to 556	5.6 to 8.1	0.2 to 0.3	0.4 to 0.6	< 0.09	< 0.01
Service Stn.L <sup>7</sup>	25	1096 to 1583	20 to 29	0.52 to 0.75	1.4 to 2.0	<0.3	< 0.03
Fleet G	30	126	54	1.1	3.7	< 0.02	< 0.04
Fleet H <sup>7</sup>	300	2.1 to 3.0	0.27 to 0.38	0.006 to 0.009	0.02 to 0.03	<0.01	<0.01
Fleet I 7	300	65 to 95	8.5 to 12	0.37 to 0.54	0.6 to 0.8	< 0.02	< 0.02
Dealership M	20	406	124	2.5	8.4	< 0.06	< 0.08
Dealership N <sup>8</sup>	110	14.5	4.4	0.09	0.30	< 0.01	< 0.01
Gen. Auto O <sup>7</sup>	20	1666 to 2410	74 to 107	1.6 to 2.3	5.0 to 7.3	< 0.4	< 0.07
Gen. Auto Q 7	60	879 to 1271	78 to 113	1.7 to 2.4	5.3 to 7.7	< 0.2	< 0.07
Gen. Auto R 7	30	362 to 523	148 to 214	3.6 to 5.2	10 to 15	<0.08	< 0.2
Gen Auto T 9	5	>731	>323	>8.7	>22	>0.2	>0.4
Gen Auto U 7	65	148 to 214	37 to 53	1.0 to 1.5	2.5 to 3.6	< 0.04	< 0.05
Gen Auto V	20	86	3.4	0.07	0.23	< 0.02	< 0.01
Brake Shop P <sup>7</sup>	30	145 to 210	34 to 49	0.97 to 1.4	2.3 to 3.3	< 0.03	< 0.04
Brake Shop S	40	34	17	0.40	1.2	< 0.01	< 0.02

<sup>1.</sup> All numbers have been rounded.

- The distance listed here is the estimated distance away from the outside edge of the building to the MEIW.
- 3. Based on maximum 1-hour emission rates. Used for the calculation of potential acute non-cancer hazard indices.
- 4. Based on annualized emission rates. Used when determining potential chronic impacts and cancer risk.
- 5. Annual average concentration are discounted by the operating schedule for the hours the facility does not emit and includes the U.S. EPA conversion factor of 0.08.
- 6. Where appropriate, the potential risk estimates are adjusted for a working lifetime of 46 years and to allow for an operating schedule at an off-site facility that does not coincide with, or is shorter than, that of the facility being assessed.
- 7. These facilities use a Perc-containing brake cleaner which shows a Perc content range from 65% to 94% by weight on the Material Safety Data Sheet (MSDS); therefore, a range is presented for the potential cancer risk.
- 8. This facility used a brake cleaner with a Perc content range of 1% to 100% by weight according to the MSDS. The
- potential cancer risk was estimated at a Perc content of 100% by weight.

  9. The MEIW is located closer than 20 meters to the center of the volume source, which is the minimum distance modeled; therefore, the potential health impacts are likely to be greater than those listed here. However, we do not anticipate the potential cancer risk will be greater than 22 chances per million due to worker adjustments discussed in note 6, nor do we anticipate significant non-cancer hazard indices. The impacts shown here are at the near-source location of 20 meters.

#### B. Methodology for Estimating the Potential Health Impacts from Brake Service Facilities

#### 1. Introduction

This section steps through an example calculation to illustrate the procedures that the ARB staff used to estimate the potential health impacts from Perc brake cleaning product emissions associated with brake service facilities. In order to estimate the impacts, staff collected product usage information, physical descriptions of the source, and emission release parameters from site visits. This information is used to estimate the facility's Perc emission rate and to model the facility's emission using the SCREEN3 air dispersion model. The modeling results are then used to determine the potential health impacts.

ARB staff used the survey form in Appendix B to help collect information necessary to model each facility's potential health risk. The more pertinent information collected includes the facility's building dimensions, distance to the nearest residential and business receptors, the operating schedule of the service area, and information about the products and their use in brake cleaning. This example calculation uses data collected from one of the site visits to better illustrate the methodology.

#### 2. The Calculation

The calculation begins with the determination of the facility's Perc usage and Perc emission rate, steps through the modeling inputs, and concludes with the calculation of potential health impacts. For our example, we have selected a minimum receptor distance of 25 meters from the center of the volume source (the building) to define a near-source location. For ease of illustration, we assume that both the maximum exposed individual resident (MEIR) and the maximum exposed individual worker (MEIW) occur at this location.

#### a. <u>Determining a Facility's Perc Usage</u>

In order to determine a facility's Perc usage, the following information is needed: the weight percent of Perc in the brake cleaning product, the approximate number of product units used per week, and the weight of the product unit itself. Our example facility was using 20 ounce cans of aerosol product with a 25 percent Perc content by weight and they reported using an average of 312 cans of product each year. The weight percent is obtained either directly from the product label or from the material safety data sheet (MSDS) for the product. The Perc usage in terms of grams per year is given by Equation 1.

(1) 
$$\left(\begin{array}{c} ounces \ of \\ 20 \ product \ per \\ can \end{array}\right) \left(\begin{array}{c} 312 \ cans \\ year \end{array}\right) \left(\begin{array}{c} 28.35 \ grams \\ ounce \end{array}\right) \left(\begin{array}{c} 25\% \ Perc \\ Content \end{array}\right) = 44,226 \ grams/year$$

### b. <u>Determining the Perc Emission Rate</u>

With the Perc usage calculated, we now estimate the acute and annualized emission rates in terms of grams per second. These conversions are necessary because they are required input parameters for the SCREEN3 model. The acute emission rate is determined by calculating the emissions from the number of brake jobs that are performed each hour by the facility. Based on information collected from the site visits, the facilities visited did not perform more than one brake service (job) in any given hour (usually limited by available manpower, tools, and equipment). Our example facility reported that they performed approximately 312 brake services per year (6 services per week). Using this information, Equation 2 calculates the acute emission rate.

(2) 
$$\frac{Emission \ Rate}{(Acute)} = \left(\frac{44,226 \ grams}{year}\right) \left(\frac{year}{312 \ jobs}\right) \left(\frac{1 \ job}{hour}\right) \left(\frac{1 \ hour}{3600 \ secs}\right) = 0.0394 \ grams/sec$$

The annualized Perc emission rate is determined by dividing the Perc usage calculated by Equation 1 by the facility's reported operating schedule. Our example facility reported that their service area operated 2808 hours per year. Using this information, Equation 3 gives the annualized emission rate uniformly distributed over the operating schedule.

(3) 
$$\frac{Emission \ Rate}{(Annualized)} = \left(\frac{44,226 \ grams}{year}\right) \left(\frac{year}{2808 \ hours}\right) \left(\frac{1 \ hour}{3600 \ secs}\right) = 0.0044 \ grams/sec$$

#### c. Running the SCREEN3 air dispersion model

Now that we know the facility's acute and annualized Perc emission rates, physical descriptions of the source, and emission release parameters, we can run the SCREEN3 air dispersion model. Table D-4 summarizes the modeling input parameters for this example. For the brake service facilities, we assumed that the single-story source release height is one-half of the building height. The initial lateral dimension of volume is assumed to be the shortest side of the building exterior divided by the factor 4.3 and the initial vertical dimension of volume is assumed to be the exterior building height divided by the factor 2.15 (U.S. EPA, 1995). These particular dimension assumptions were selected to represent a modeling scenario that can be generally applied to various sized (e.g. rectangular) brake service facilities. Our example facility is located in an urban area (as well as all of the facilities visited) and is approximately 23 meters from the center to the edge of the building.

Table D-4. Modeling Input Parameters for Example Facility

Perc Emission Rate (acute) [grams/s]	0.0394
Perc Emission Rate (annualized) [grams/s]	0.0044
Receptor Height [meters] <sup>1</sup>	0
Source Release Height [meters] <sup>2</sup>	2.286
Initial Lateral Dimension of Volume $(\sigma_{yo})$ [meters] <sup>3</sup>	3.246
Initial Vertical Dimension of Volume $(\sigma_{zo})$ [meters] <sup>4</sup>	2.127
Meteorology Option	Full
Land Type [Urban or Rural]	Urban
Receptor Distance (from center of source)	25
Operating Schedule [hrs/yr]	2808

- 1. Selected by convention as a ground-level receptor.
- 2. One-half of building height (15 feet, 4.57 meters)
- 3. Exterior building width (45.8 feet, 13.96 meters) divided by factor 4.3 per SCREEN3 User's Guide
- 4. Exterior building height (15 feet, 4.57 meters) divided by factor 2.15 per SCREEN3 User's Guide

The SCREEN3 model uses these inputs to estimate the downwind, ground-level, maximum 1-hour concentrations for designated distances from the center of the volume source. The estimated acute maximum 1-hour concentration at 25 meters from the center of the facility is  $446.1~\mu g/m^3$  and the estimated annualized (chronic) 1-hour concentration is  $49.84~\mu g/m^3$ . It should be noted that the SCREEN3 model must be run twice; once using the acute emission rate and once using the annualized emission rate. A summary of the output from the SCREEN3 model is shown in Section D of this Appendix (Facility Modeling Results). For more information on the SCREEN3 model, please refer to the SCREEN3 model user's guide (U.S. EPA, 1995).

Since potential cancer risks and non-cancer chronic health impacts require an assessment of the annual average concentration of Perc, the U.S. EPA conversion factor of 0.08 (U.S. EPA, 1992) is used to estimate the maximum annual average concentration from the annualized maximum 1-hour concentration. In addition, the maximum annual average concentration is discounted by the operating schedule for the hours the facility does not emit. The maximum annual average concentration is calculated by using Equation 4.

Substituting in the example data, Equation 5 is used to give the maximum annual average concentration of 1.278  $\mu g/m^3$ .

(5) 
$$\frac{Max \ Ann. \ Avg.}{Concentration} = \left(49.84 \ \frac{\mu g}{m^3}\right) \left(2808 \ \frac{hours}{year}\right) \left(\frac{1 \ year}{8760 \ hours}\right) \ 0.08 = 1.278 \ \mu g/m^3$$

# d. <u>Calculation of Potential Cancer Risk and Non-Cancer</u> Acute and Chronic Hazard Indices

With the modeling complete, we can combine the modeling output with the unit risk factor (cancer effects) or the reference exposure level (non-cancer effects) to determine the potential cancer risk and corresponding acute and chronic hazard indices. The risk assessments are conducted using guidance from the California Air Pollution Control Officers Association (CAPCOA) Revised 1992 Air Toxic "Hot Spots" Program Risk Assessment Guidelines (CAPCOA, 1993). For this example, we calculated the potential cancer and non-cancer health impacts at a near-source location of 25 meters from the center of the volume source (two meters away from the edge of the building). We also assumed that a MEIR (resident) and a MEIW (worker) are exposed to the same concentration. The inhalation unit risk factor (URF) for Perc is  $5.9 \times 10^{-6} (\mu g/m^3)^{-1}$ ; the acute non-cancer reference exposure level (REL) is  $6.8 \times 10^3 \ \mu g/m^3$  and the chronic REL is  $35 \ \mu g/m^3$  (CAPCOA, 1993). Equation 6 shows the basic algorithm for determining the potential cancer risk, in chances per million, for a residential location (MEIR).

The factor 10<sup>6</sup>/million is used to convert the result into the standard reporting unit, chances per million. Substituting in the maximum annual average concentration from Equation 5 and the Perc URF, Equation 7 gives us the potential cancer risk for a residential receptor 25 meters away from the center of the building.

(7) 
$$\frac{Cancer\ Risk}{(Resident)} = \left(1.278\ \frac{\mu g}{m^3}\right) \left(5.9\ x\ 10^{-6} \frac{m^3}{\mu g}\right) \left(\frac{10^6}{million}\right) = 7.5\ chances\ per\ million$$

Equation 8 gives the formula for calculating the potential risk for an off-site worker. Using guidance from OEHHA, the exposure period of an off-site worker is adjusted to allow for a shorter working lifetime and a shorter operating schedule. This first adjustment is made to allow for a shorter working lifetime, 46 years, rather than a 70-year exposure lifetime which is assumed for residential exposure. The second adjustment is appropriate only when the offsite worksite

schedule does not coincide with or is shorter than that of the facility being assessed (OEHHA, 1997). It is assumed that a nearby worker would be exposed 8 hours a day, 240 days a year (1920 hours/year) for 46 years (CAPCOA, 1993).

(8) 
$$\frac{Cancer\ Risk}{(Worker)} = \binom{Max\ Ann.\ Avg.}{Concentration} (URF) \underbrace{\left(\frac{Offsite\ Worker\ Coincident}{Operating\ Schedule\ [hr/yr]}}_{Schedule\ [hr/yr]} \underbrace{\left(\frac{46-year}{Working\ Lifetime}}_{T0-year\ Residential\ Lifetime}\right)}_{Residential\ Lifetime} \underbrace{\left(\frac{10^6}{million}\right)}_{Tiber}$$

Substituting in the maximum annual average concentration from Equation 5, the URF, and the operating schedule (2808 hours per year, for this example), Equation 9 gives the risk for an offsite worker.

(9) 
$$\frac{Cancer\ Risk}{(Worker)} = \left(1.278\ \frac{\mu g}{m^3}\right) \left(5.9x10^{-6}\ \frac{m^3}{\mu g}\right) \left(\frac{1920\ hrs/yr}{2808\ hrs/yr}\right) \left(\frac{46}{70}\ \frac{years}{years}\right) \left(\frac{10^6}{million}\right) = 3.4\ \frac{chances}{per\ million}$$

Equations 10 and 11 give the formulas for calculating the non-cancer acute and chronic hazard indices, respectively. The acute hazard index is determined by taking the acute maximum 1-hour concentration (acute exposure) and dividing by the acute REL of  $6800 \, \mu g/m^3$ . Similarly, the

(10) 
$$Acute \\ Hazard = \underbrace{\begin{pmatrix} Maximum \ 1-hr. \\ Concentration \\ (Acute) \end{pmatrix}}_{Index} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ Hazard = \\ Index \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ Index \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Chronic \\ Chronic \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL \end{pmatrix}}_{Chronic} = \underbrace{\begin{pmatrix} Max. \ Ann. \ Avg. \\ Concentration \\ REL$$

chronic hazard index is determined by taking the maximum annual average concentration (chronic exposure) and dividing by the chronic REL of 35  $\mu g/m^3$ . Finally, Equations 12 and 13 solve for the acute and chronic hazard indices, respectively.

(12) 
$$Acute Hazard = \frac{\left(446.1 \frac{\mu g}{m^3}\right)}{\left(6800 \frac{\mu g}{m^3}\right)} = 0.066$$

$$(13) Chronic Hazard = \frac{\left(1.278 \frac{\mu g}{m^3}\right)}{\left(35 \frac{\mu g}{m^3}\right)} = 0.037$$

Table D-5 summarizes the results that have been calculated in this example. A summary of results from the modeling performed on each of the facilities visited is presented in Section D of this appendix.

**Table D-5. Summary of Results from Example Calculation** 

Parameter	Result	Reference
Perc Emission Rate (acute), [grams/s]	0.0394	Equation 2
Perc Emission Rate (annualized) [grams/s]	0.0044	Equation 3
Maximum 1-hr Concentration (acute), [μg/m³]	446.1	SCREEN3 Model Output
Maximum 1-hr Concentration (annualized), [µg/m³]	49.84	SCREEN3 Model Output
Maximum Annual Average Concentration, [µg/m³]	1.278	Equation 5
Cancer Risk (Resident) [chances per million]	7.5	Equation 7
Cancer Risk (Worker) [chances per million]	3.5	Equation 9
Non-Cancer Acute Hazard Index	0.066	Equation 12
Non-Cancer Chronic Hazard Index	0.037	Equation 13

#### C. Selection of the SCREEN3 Model

A sensitivity study is conducted to show that the emissions from the brake service facility may be modeled by two different methods to estimate the acute and chronic hazard indices and the cancer risk. The first method assumes the emissions are uniformly distributed over the operating schedule and the SCREEN3 air dispersion model is used. The second method assumes the emissions are released as intermittent puffs and the EPA-INPUFF (INPUFF) model is used. The sensitivity study shows that both modeling approaches result in similar concentrations. The SCREEN3 air dispersion model is selected for further work because it is easiest to use. Table D-6 summarizes the source characteristics.

Table D-6. Source Characteristics for SCREEN3-INPUFF Comparison

Parameter	Value
Building Height	9.45 m ( $\sigma_{zo} = 4.395$ m)
Building Width	22.35 m ( $\sigma_{yo} = 5.196$ m)
Source Release Height	4.72 m
Meteorology Option	Full
Land Type [Urban or Rural]	Urban
Operating Schedule	M-F 6:30 am to 1 am (18.5 hours per day)
Number of Brake Services	23 cars per week (4.6 cars per day)
Product Usage Per Brake Service	1 20-oz can of product per brake service (533 grams Perc per brake service at 94% Perc)
Application Information	1 minute of spraying per wheel (2.22 grams/sec for 60 seconds at each wheel)

It is assumed that brake cleaning is uniformly distributed over 20 minutes. That is, every 5 minutes the brakes from one wheel are cleaned for one minute. In addition, no more than one brake job is completed per hour.

It is also assumed the emissions can be characterized as a volume source due to the nature of the mechanical mixing within the garage and the downwash and cavity effects that occur on the lee side of the building. For the SCREEN3 input data, a volume source is assumed with the above dimensions. The maximum 1-hour emission rate (needed for the acute hazard index) is the emission from one brake job, 0.148 grams/sec (533 grams/3600 sec). For the annual average analysis, Equation 14 gives the annualized emission rate of 0.0368 grams/sec.

(14) 
$$\left(\frac{533 \text{ grams}}{car}\right) \left(\frac{23 \text{ cars}}{\text{week}}\right) \left(\frac{\text{week}}{5 \text{ workdays}}\right) \left(\frac{\text{workday}}{18.5 \text{ hrs}}\right) \left(\frac{\text{hr}}{3600 \text{ sec}}\right) = 0.0368 \text{ grams/sec}$$

For the INPUFF input, the source characteristics are the same as those for SCREEN3. However the emission rate for INPUFF is higher for shorter durations, 2.22 grams/sec for 60 seconds. The INPUFF model can disperse the downwind emissions via a distance dependent dispersion curve or a time dependent dispersion curve. The INPUFF model recommends the time dependent dispersion curves for near field receptors, as is the case for the maximum receptor concentration at brake facilities. For this sensitivity analysis, both dispersion options are used.

The SCREEN3 dispersion model determined that the maximum short term ground level concentration from this facility is for a wind speed of 1 meter per second and a Pasquill Gifford Stability Class of 5. As such, this is the input for the INPUFF model too.

To determine the maximum annual average concentration from SCREEN3, the maximum 1-hour concentration is multiplied by the EPA scaling factor of 0.08 and then prorated for the hours the facility does not emit, since the EPA scaling factor assumes constant steady state emissions. A similar procedure is used for the INPUFF results. INPUFF calculates both the 1-minute average concentration as well as the 1-hour average concentration. The table below summarizes the results of this analysis at receptor distances of 25, 100, and 200 meters.

Table D-7. Maximum Perchloroethylene Above Ambient Air Concentration at Various Receptor Distances, Averaging Times, and Modeling Approaches

Receptor Distance	25 m		100 m			200 m			
Avg Time	1-Min	1-Hr	Ann	1-Min	1-Hr	Ann	1-Min	1-Hr	Ann
	Max. Conc. [μg/m³]								
SCREEN3	N/E <sup>1</sup>	720	7.9	N/E <sup>1</sup>	240	2.6	N/E <sup>1</sup>	100	1.1
INPUFF Distance	8000	920	10	4300	490	5.4	2400	270	3.0
INPUFF Time	3600	450	4.9	1400	170	1.9	750	92	1.0

1. N/E: not estimated

Equation 15 shows how the annual average concentration is determined from the maximum 1-hour concentration at 25 meters from the SCREEN3 output.

(15) 
$$\left(720 \frac{\mu g}{m^3}\right) \left(\frac{0.0368 \text{ g/sec}}{0.148 \text{ g/sec}}\right) \left(\frac{18.5 \text{ hrs/workday}}{24 \text{ hrs/day}}\right) \left(\frac{260 \text{ days/workyr}}{365 \text{ days/yr}}\right) 0.08 = 7.9 \frac{\mu g}{m^3}$$

Equation 16 shows how the annual average concentration is determined from the maximum 1-hour concentration at 25 meters from the INPUFF model output.

(16) 
$$\left(450 \frac{\mu g}{m^3}\right) \left(\frac{4.6 \ hrs/workday}{24 \ hrs/day}\right) \left(\frac{260 \ days/workyr}{365 \ days/yr}\right) \ 0.08 = 4.9 \frac{\mu g}{m^3}$$

The results shown in the above table show that the results from the SCREEN3 modeling analysis is greater than the INPUFF results using the recommended time dependent dispersion curve for near field receptors and is less than the INPUFF results using the distance dependent dispersion curve. Based on this sensitivity analysis, the results from SCREEN3 are comparable to results from INPUFF for near field receptors to estimate 1-hour and long term impacts. Therefore, SCREEN3 is a simplified and viable alternative to evaluate the near field impacts from emissions from the brake service facilities.

# D. Facility Modeling Results

This section of Appendix D summarizes the results from our modeling of the 16 facilities that used Perc-containing brake cleaning products. Tables D-8 thru D-10 present the modeling input parameters for each modeled facility and tables D-11 thru D-13 summarize the modeling results.

Table D-8. Modeling Input Parameters for Facilities D, E G, H, and I

Parameter	Value						
	Facility D Facility E Facility G <sup>1</sup>		Facility H	Facility I			
Source Type	Volume	Volume	Vol	ume	Volume	Volume	
Facility Type	Service Station	Service Station	Fleet		Fleet	Fleet	
Perc Emission Rate [grams/s]	0.0044	$0.0071 \text{ to} \\ 0.00102^2$	0.01853		0.00095 to 0.00137 <sup>2</sup>	0.0236 to 0.0342 <sup>2</sup>	
Receptor Height [m]	0	0	0		0	0	
Source Release Height [m]	2.286	2.896	1.829	3.658	4.572	4.724	
Initial Lateral Dimension of Volume [m]	3.246	1.949	2.761	10.071	12.995	5.196	
Initial Vertical Dimension of Volume [m]	2.127	2.694	1.701	2.127	4.253	4.395	
Meteorology Option	Full	Full	Full		Full	Full	
Land Type (Urban or Rural)	Urban	Urban	Urban		Urban	Urban	
Operating Schedule [hrs/wk]	54	69	42	2.5	47.5	92.5	

<sup>1.</sup> Due to the relationship between the exterior building dimensions to the location of the actual service area, two SCREEN3 runs were completed. The data in the left-hand column is used to calculate the non-cancer acute hazard index and the data in the right-hand column is used to calculate overall cancer risk and chronic non-cancer hazard index.

<sup>2.</sup> These facilities use a Perc-containing brake cleaning product which shows a Perc content range from 65% to 94% by weight on the Material Safety Data Sheet; therefore a range is presented for the Perc emission rate.

Table D-9. Modeling Input Parameters for Facilities L, M, N, O, and P

Parameter	Value							
	Facility L	Facility M	Facility N	Facility O	Facility P			
Source Type	Volume	Volume	Volume	Volume	Volume			
Facility Type	Service Station	Car Dealership	Car Dealership	Gen Auto	Brake Shops			
Emission Rate [grams/s]	0.0025 to 0.0036 <sup>1</sup>	0.0185	0.00231	0.00865 to 0.01251 <sup>1</sup>	0.00425 to 0.00614 <sup>1</sup>			
Receptor Height [m]	0	0	0	0	0			
Source Release Height [m]	2.286	2.591	2.286	3.048	3.048			
Initial Lateral Dimension of Volume [m]	3.573	5.316	3.190	3.544	2.481			
Initial Vertical Dimension of Volume [m]	2.127	2.410	2.127	2.835	2.835			
Meteorology Option	Full	Full	Full	Full	Full			
Land Type (Urban or Rural)	Urban	Urban	Urban	Urban	Urban			
Operating Schedule [hrs/wk]	54	42.5	42.5	45	60			

<sup>1.</sup> These facilities use a Perc-containing brake cleaning product which shows a Perc content range from 65% to 94% by weight on the Material Safety Data Sheet; therefore a range is presented for the Perc emission rate.

Table D-10. Modeling Input Parameters for Facilities  $Q,\,R,\,S,\,T,\,U$  and V

Parameter			Va	alue		
	Facility Q	Facility R	Facility S	Facility T	Facility U	Facility V
Source Type	Volume	Volume	Volume	Volume	Volume	Volume
Facility Type	Gen Auto	Gen Auto	Brake Shops	Gen Auto	Gen Auto	Brake Shops
Emission Rate [grams/s]	0.0260 to 0.0375 <sup>1</sup>	0.0227 to 0.0328 <sup>1</sup>	0.0028	0.0166	0.0097 to 0.0141 <sup>1</sup>	0.00023
Receptor Height [m]	0	0	0	0	0	0
Source Release Height [m]	3.048	2.438	2.743	1.829	3.048	2.286
Initial Lateral Dimension of Volume [m]	4.749	4.253	2.835	2.127	2.127	2.127
Initial Vertical Dimension of Volume [m]	2.835	2.268	2.552	1.701	2.835	2.127
Meteorology Option	Full	Full	Full	Full	Full	Full
Land Type (Urban or Rural)	Urban	Urban	Urban	Urban	Urban	Urban
Operating Schedule [hrs/wk]	45	51.5	50	56.5	60	45

<sup>1.</sup> These facilities use a Perc-containing brake cleaning product which shows a Perc content range from 65% to 94% by weight on the Material Safety Data Sheet; therefore a range is presented for the Perc emission rate.

Table D-11. Summary of Modeling Results for Facilities D, E, G, H, and I

FACILITY	RECEPTOR TYPE	Receptor I		Maximum 1-hour Conc. (acute) [μg/m³]	Maximum 1-hour Conc. (annualized) [μg/m³]	Maximum Annual Avg. Conc. [μg/m³]	Potential Cancer Risk [chances per million]		Hazard Index	
		Center <sup>1</sup>	Env. <sup>2</sup>				Resident	Worker	Acute	Chronic
D	Near-Source	25	2	446.1	49.84	1.2781	7.54	3.39	0.0656	0.0365
	MEIW	55	32	206.2	23.04	0.5908	3.49	1.57	0.0303	0.0169
	MEIR	175	152	40.36	4.509	0.1156	0.68	0.31	0.0059	0.0033
$\mathbf{E}^3$	Near-Source	20	16	710.0 to 1026	10.29 to 14.87	0.3372 to 0.4872	1.99 to 2.87	0.70 to 1.01	0.1044 to 0.1509	0.0096 to 0.0139
	MEIW	40	36	384.9 to 556.2	5.578 to 8.061	0.1828 to 0.2641	1.08 to 1.56	0.38 to 0.55	0.0566 to 0.0818	0.0052 to 0.0075
	MEIR	805	801	4.44 to 6.41	0.0642 to 0.0929	0.0021 to 0.0030	0.01 to 0.02	0.00 to 0.01	0.0007 to 0.0009	0.0001 to 0.0001
G	Near-Source	25	3	263	76.32	1.54	9.09	5.19	0.0387	0.0440
	MEIW	50	28	125.6	54.16	1.09	6.45	3.68	0.0185	0.0312
	MEIR	420	398	4.76	4.109	0.08	0.49	0.28	0.0007	0.0024
$H^3$	Near-Source	30	2	17.89 to 25.81	2.265 to 3.267	0.0511 to 0.0737	0.30 to 0.43	0.15 to 0.22	0.0026 to 0.0038	0.0015 to 0.0021
	MEIW	330	302	2.10 to 3.02	0.2652 to 0.3825	0.0060 to 0.0086	0.04 to 0.05	0.02 to 0.03	0.0003 to 0.0004	0.0002 to 0.0002
	MEIR	830	802	0.58 to 0.83	0.0728 to 0.105	0.0016 to 0.0024	0.01 to 0.01	0.00 to 0.01	0.0001 to 0.0001	0.0000 to 0.0001
$\mathbf{I}^3$	Near-Source	20	9	971.7 to 1408	126.2 to 182.8	5.5436 to 8.0298	32.71 to 47.38	8.58 to 12.43	0.1429 to 0.2070	0.1584 to 0.2294
	MEIW	310	299	65.30 to 94.63	8.481 to 12.29	0.3725 to 0.5399	2.20 to 3.19	0.58 to 0.84	0.0096 to 0.0139	0.0106 to 0.0154
	MEIR	310	299	65.30 to 94.63	8.481 to 12.29	0.3725 to 0.5399	2.20 to 3.19	0.58 to 0.84	0.0096 to 0.0139	0.0106 to 0.0154

Distance to receptor measured from the center of the volume source.
 Distance to receptor measured from the building exterior (envelope).

<sup>3.</sup> These facilities use a Perc-containing brake cleaner which shows a Perc content range from 65% to 94% by weight on the Material Safety Data Sheet; therefore, a range is presented for the results.

Table D-12. Summary of Modeling Results for Facilities L, M, N, O, and P

FACILITY	RECEPTOR TYPE	Receptor Distance [meters]		Maximum 1-hour Conc.	Maximum 1-hour Conc. (annualized) [μg/m³]	Maximum Annual Avg. Concentration [μg/m³]	Potential Cancer Risk [chances per million]		Hazard Index	
			Env. <sup>2</sup>	(acute) [μg/m³]			Resident	Worker	Acute	Chronic
$\mathbf{L}^{3}$	Near-Source	20	12	1689 to 2439	31.27 to 45.16	0.8019 to 1.1581	4.73 to 6.83	2.13 to 3.07	0.2483 to 0.3586	0.0229 to 0.0331
	MEIW	35	27	1096 to 1583	20.3 to 29.31	0.5206 to 0.7516	3.07 to 4.43	1.38 to 1.99	0.1612 to 0.2328	0.0149 to 0.0215
	MEIR	240	232	82.89 to 119.7	1.535 to 2.216	0.0394 to 0.0568	0.23 to 0.34	0.10 to 0.15	0.0122 to 0.0176	0.0011 to 0.0016
M	Near-Source	20	9	529.7	162	3.2696	19.29	11.01	0.0779	0.0934
	MEIW	31	20	406.1	124.2	2.5067	14.79	8.44	0.0597	0.0716
	MEIR	26	15	457.2	139.8	2.8215	16.65	9.50	0.0672	0.0806
N	Near-Source	20	13	101.8	30.95	0.6247	3.69	2.10	0.0150	0.0178
	MEIW	117	110	14.46	4.394	0.0887	0.52	0.30	0.0021	0.0025
	MEIR	407	400	2.01	0.6123	0.0124	0.07	0.04	0.0003	0.0004
$O_3$	Near-Source	20	12	1956 to 2828	86.95 to 125.7	1.8581 to 2.6862	10.96 to 15.85	5.91 to 8.55	0.2877 to 0.4159	0.0531 to 0.0767
	MEIW	26	18	1666 to 2410	74.05 to 107.1	1.5824 to 2.2887	9.34 to 13.50	5.03 to 7.28	0.2450 to 0.3544	0.0452 to 0.0654
	MEIR	99	91	424.6 to 614.0	18.87 to 27.29	0.4032 to 0.5832	2.38 to 3.44	1.28 to 1.86	0.0624 to 0.0903	0.0115 to 0.0167
$\mathbf{P}^3$	Near-Source	20	15	224.3 to 324.04	52.4 to 75.71	1.4930 to 2.1572	8.81 to 12.73	3.56 to 5.15	0.0330 to 0.0477	0.0427 to 0.0616
	MEIW	35	30	145.3 to 209.9	33.95 to 49.04	0.9673 to 1.3973	5.71 to 8.24	2.31 to 3.33	0.0214 to 0.0309	0.0276 to 0.0399
	MEIR	29	24	171.2 to 247.3	39.99 to 57.77	1.1394 to 1.646	6.72 to 9.71	2.72 to 3.93	0.0252 to 0.0364	0.0326 to 0.0470

<sup>1.</sup> Distance to receptor measured from the center of the volume source.

<sup>2.</sup> Distance to receptor measured from the building exterior (envelope).

<sup>3.</sup> These facilities use a Perc-containing brake cleaner which shows a Perc content range from 65% to 94% by weight on the Material Safety Data Sheet; therefore, a range is presented for the results.

Table D-13. Summary of Modeling Results for Facilities Q, R, S, T, U, and V

FACILITY	RECEPTOR TYPE	Receptor Distance [meters]		Maximum 1-hour Conc.	Maximum 1-hour Conc.	Maximum Annual Avg.	Potential Cancer Risk [chances per million]		Hazard Index	
		Center <sup>1</sup>	Env. <sup>2</sup>	(acute) [μg/m³]	(annualized) [μg/m³]	Concentration [μg/m³]	Resident	Worker	Acute	Chronic
$Q^3$	Near-Source	20	10	2427 to 3509	215.7 to 311.9	4.6095 to 6.6653	27.20 to 39.33	14.66 to 21.20	0.3569 to 0.5160	0.1317 to 0.1904
	MEIW	71	61	879.3 to 1271	78.16 to 113	1.6703 to 2.4148	9.85 to 14.25	5.31 to 7.68	0.1293 to 0.1869	0.0477 to 0.0690
	MEIR	86	76	701.7 to 1015	62.37 to 90.21	1.3328 to 1.9278	7.86 to 11.37	4.24 to 6.13	0.1032 to 0.1492	0.0381 to 0.0551
$\mathbb{R}^3$	Near-Source	20	11	592.9 to 857.0	242 to 349.8	5.9185 to 8.5549	34.92 to 50.47	16.45 to 23.78	0.0872 to 0.1260	0.1691 to 0.2444
	MEIW	39	30	361.9 to 523.3	147.7 to 213.6	3.6122 to 5.2239	21.31 to 30.82	10.04 to 14.52	0.0532 to 0.0770	0.1032 to 0.1493
	MEIR	55	46	255.8 to 369.7	104.4 to 150.9	2.5533 to 3.6905	15.06 to 21.77	7.10 to 10.26	0.0376 to 0.0544	0.0730 to 0.1054
S	Near-Source	20	14	70.62	35.31	0.8384	4.95	2.40	0.0104	0.0240
	MEIW	47	41	34.10	17.05	0.4048	2.39	1.16	0.0050	0.0116
	MEIR	466	460	1.20	0.6011	0.0143	0.08	0.04	0.0002	0.0004
T	Near-Source	20	15	730.7	323.3	8.6745	51.18	21.98	0.1074	0.2478
	MEIW <sup>4</sup>	11	6	>730.7	>323.3	>8.6745	>51.18	>21.98	>0.1074	>0.2478
	MEIR	35	30	423.5	187.4	5.0281	29.67	12.74	0.0623	0.1437
$\mathrm{U}^3$	Near-Source	20	15	519.2 to 750.0	129.8 to 187.5	3.6984 to 5.3425	21.82 to 31.52	8.82 to 12.75	0.0764 to 0.1103	0.1057 to 0.1526
	MEIW	71	66	147.8 to 213.6	36.96 to 53.4	1.0531 to 1.5215	6.21 to 8.98	2.51 to 3.63	0.0217 to 0.0314	0.0301 to 0.0435
	MEIR	96	91	98.16 to 141.9	24.54 to 35.47	0.6992 to 1.0107	4.13 to 5.96	1.67 to 2.41	0.0144 to 0.0209	0.0200 to 0.0289
V	Near-Source	20	15	86.41	3.837	0.0820	0.48	0.26	0.0127	0.0023
	MEIW	23	18	77.38	3.436	0.0734	0.43	0.23	0.0114	0.0021
	MEIR <sup>5</sup>	11	6	>86.41	>3.837	>0.0820	>0.48	>0.26	>0.0127	>0.0023

<sup>1.</sup> Distance to receptor measured from the center of the volume source.

<sup>2.</sup> Distance to receptor measured from the building exterior (envelope).

<sup>3.</sup> These facilities use a Perc-containing brake cleaner which shows a Perc content range from 65% to 94% by weight on the Material Safety Data Sheet; therefore, a range is presented for the results.

<sup>4.</sup> The MEIW is located closer than 20 meters to the center of the volume source, which is the minimum distance modeled; therefore, the potential health impacts are likely to be greater than those listed here. However, we do not anticipate the potential cancer risk will be greater than 22 chances per million due to worker adjustments, nor do we anticipate significant non-cancer hazard indices. The impacts shown here are at the near-source location of 20 meters.

<sup>5.</sup> The MEIR is located closer than 20 meters to the center of the volume source, which is the minimum distance modeled; therefore, the potential health impacts are likely to be greater than those listed here. However, we do not anticipate that the potential health impacts will be significant. The impacts shown here are at the near-source location of 20 meters.

#### REFERENCES FOR APPENDIX D

CAPCOA, 1993. <u>CAPCOA Air Toxics "Hot Spots" Program - Revised 1992 Risk Assessment Guidelines</u>, Toxics Committee of the California Air Pollution Control Officer Association (CAPCOA), October 1993.

OEHHA, 1997. Telephone conversation with Melanie Marty, Manager, Air Risk Assessment Unit, Office of Environmental Health Hazard Assessment, and Greg Harris, on May 19, 1997.

U.S. EPA, 1995. <u>SCREEN3 Model User's Guide</u>, EPA-454/B-95-004, United States Environmental Protection Agency (U.S. EPA), Research Triangle Park, North Carolina, September 1995.

U.S. EPA, 1992. <u>Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised</u>, United States Environmental Protection Agency (U.S. EPA), October 1992.

Appendix E

Glossary

#### **GLOSSARY**

One or a series of short-term exposures generally lasting less than Acute Exposure:

24 hours.

Air Dispersion

Model:

A mathematical model or computer simulation used to estimate the concentration of toxic air pollutants at specific locations as a result of

mixing in the atmosphere.

Cancer Risk: The theoretical probability of contracting cancer when exposed for a

> lifetime to a given concentration of a substance usually calculated as an upper confidence limit. The maximum estimated risk may be presented as

the number of chances in a million of contracting cancer.

Chronic Exposure: Long-term exposure usually lasting from one year to a lifetime.

Hazard Index: The ratio of the concentration of a toxic pollutant with non-cancer health

effects and the reference exposure level for that pollutant.

Health Risk

A comprehensive analysis of the dispersion of hazardous substances in the

Assessment (HRA): environment, their potential for human exposure, and a quantitative

assessment of both individual and population-wide health risks associated

with those levels exposed.

MEIR: Maximum exposed individual resident. The residential receptor location

that receives the estimated maximum exposure from a facility's emissions

relative to other residential locations.

MEIW: Maximum exposed individual worker. The off-site industrial or

> commercial location that receives the estimated maximum exposure from a facility's emissions relative to other industrial or commercial locations.

Non-cancer Risk: Refers to non-cancer health effects due to acute and/or chronic exposure.

This may be illustrated as an estimate of the hazard index or total hazard

index (by endpoint) resulting from exposure to toxic air pollutants.

Level (REL):

Reference Exposure These are used as indicators of potential non-cancer adverse health effects.

An REL is a concentration level at or below which no adverse health effects are anticipated. RELs are designed to protect most sensitive

individuals in the population by including safety factors in their

development.

Risk: The possibility of injury or disease, which may result from exposure to

toxic air pollutants.

Total Hazard Index: The sum of hazard indices for pollutants with non-cancer health effects that

have the same or similar adverse health effects (endpoints).

Unit Risk Factor

(URF):

The estimated upper-confidence limit (usually 95%) probability of a

person contracting cancer as a result of a constant exposure to  $1\mu g/m^3$  of a

substance over a 70-year lifetime.